〔Article〕

The interfirm relationship in LCD materials industry : the market and organizational principle[1]

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Contents

INTRODUCTION

The purpose of this paper is to analyze the interfirm relationship in LCD(liquid-crystal display) materials industry, focusing on the market and organizational principle.[2]

In the LCD materials industry, many Japanese companies are strongly competitive and still lead the global market. As will be described later, the interfirm relationships between suppliers and customers were significant to the strong competitiveness of Japanese companies in this industry.[3]

Many scholars emphasize that Japan's interfirm relationships are illustrated by "obligational contractual relationships", primarily reflecting the organizational principle while those of the United States and some European countries are represented by "arm's length contractual relationships", which are highly susceptible to market principles.[4] Nevertheless, it goes without saying that not all transactions in Japan are based on long-term and continual contracts. In other words, interfirm

relationships in Japan follow the market principle as well as the organizational principle.

Moreover, it seems highly likely that both principles are closely intertwined in interfirm relationships. There are many existing theoretical studies on interfirm relationships such as the research by the International Marketing and Purchasing (IMP) Group[5] which primarily focus on the cooperation and interaction between customers and suppliers - that is, only on the organizational principle in the terms set out by this article. However, as this article will show, we should shed light on the intertwining between the market and the organizational principles in order to develop a theory of interfirm relationships. In fact, in interfirm relationship of LCD materials industry, the organizational principle and the market principle coexist and are interrelated. Hence, I focus on the intertwining between the two principles in the LCD materials industry in this article.

Furthermore, Japanese LCD materials firms conduct frequent transactions with foreign customers as Japanese LCD companies were overtaken by South Korean and Taiwanese LCD companies in the 2000s. Consequently, the internationalized management environment in LCD materials industry prevented the interfirm relationship from turning into something that could easily be characterized as "uniquely Japanese". Therefore, this article explores the international interfirm relationship between Japanese LCD materials companies and foreign LCD companies.

1 THE SOURCES OF STRONG COMPETITIVENESS OF JAPANESE LCD MATERIALS FIRMS

1.1 Strong Competitiveness of Japanese LCD Materials Firms

Many materials that share a common technology and market characteristics are needed to manufacture LCDs. For example, retardation film, color filters, alignment layers, ITO film, and LCD glass substrates are LCD materials. Additionally, backlights, spacers, and materials for sealing liquid crystal are also classified as LCD materials. Therefore, the LCD materials market is segmented. In these market segments, many Japanese LCD materials companies are strongly competitive, in contrast to the Japanese LCD firms that were overtaken by the South Korean and Taiwanese LCD companies. In fact, Japanese LCD materials firms are at the top of the world market and held about 80 percent of the world LCD materials market. In particular, Japanese firms occupied 100 percent of the market for blue LCD glass substrate, anti-glare film, Triacetyl Cellulose (TAC) film,[6] viewing angle expansion film, spacers, seals for LCDs, and pigment dispersion materials for color film and resin black matrix.[7]

In 2012, Japanese companies held the top two positions in most materials markets, such as the markets for polarizers, polyvinyl alcohol film (PVA), retardation film, and alignment layers for LCDs (see Table 1). While Japan was not ranked at the top for LCD glass substrates, the Japanese companies Asahi Glass, Nippon Electric Glass and Avan Strate had about half of the market share.

1.2. Sources of Competitiveness: Technology Barriers to Entry

1.2.1 Oligopoly and barriers to entry

Japanese companies are strong in the LCD materials market for many reasons. Specifically, the industrial organization in this industry is an oligopoly. As shown in Table 1, the number of incumbents is small and only two to four companies have a dominant position in each market segment. In the world market for LCD glass substrates, there are five incumbent firms, including the four firms mentioned previously and Schott AG, a German firm. Hence, these oligopolistic market segments primarily consist of Japanese firms.

The oligopolistic structure of the LCD materials industry creates a firm barrier to new entry. Equally, the barrier to entry is strengthened by this oligopolistic structure. In sum, the oligopolistic structure and barrier to entry have a

Table 1 Market shares by Japanese companies in LCD materials market segments (2012, %)

Name of product	First	Second	Third
Polarizing plate	Nitto Denko (35)	Sumitomo Chemical (25)	–
Polyvinyl alcohol (PVA) film	Kuraray (76)	Nippon Gohsei (24)	–
Retardation film	Konica Minolta (40)	Fuji Film (35)	JSR (5)
Alignment layer for large size LCD	JSR (75–80)	Nissan Chemical Industry (15–20)	–
Alignment layer for small and mid-size LCD	Nissan Chemical Industry (about 90)	JSR (about 10)	–
LCD glass substrates	Asahi Glass (25)	Nippon Electric Glass (20)	Avan Strate (4)

strong influence on each other.

The factors of barriers to entry are classified as investment barriers, which are strongly influenced by financial factors, and technological barriers. In particular, in this industry, technological barriers are more important than investment barriers.

The Japanese firms that entered this industry early, even though they were not big and had little in the way of funds or finance, have been successful. If the investment barriers of the industry had been high, these companies would most likely have failed to enter the market. Currently, there are many medium sized companies in this industry. As such, we can infer that the investment barriers to entry are not high for the LCD materials industry.[8]

1.2.2 High-technology barriers to entry

Thus, understanding the technological barriers to entry is important for the LCD materials industry. Above all, it takes time to accumulate the technologies and knowledge to develop and mass-produce LCD materials.

For example, as the size of the glass substrates for LCDs became larger, it became more critical to decrease the amount of deflection and enhance strength. It was necessary to lower the ratio of shrinkage to swelling caused by heat. In addition, it became more important to prevent flaws and contamination to increase the yield rate. Ultimately, along with the enlargement of glass for LCDs, manufacturing became more difficult, thus requiring a higher degree of production and product technologies, which take time to learn.

Furthermore, the enlargement of LCDs required a higher level of optical characteristics of PVA and TAC films, the primary materials for LCD polarizers. Consequently, it became more difficult to process the films and, as a result, quality control in manufacturing these films became challenging. To be precise, a high degree of technology is needed to make the thickness of films even and decrease contamination and defects. This can be attained by accumulating experience in mass production.

As the size of LCD polarizers increased, the specifications for manufacture became stricter. For example, manufacturers of LCD polarizers must prevent contamination by foreign matter and decrease surface irregularity. To meet the amount and quality requested by customers, a high level of production technology needs to be accumulated on the shop floor.[9]

Additionally, in manufacturing most of the materials for LCD backlights, technologies from various sources[10] are required, which take time to learn.

This suggests that success in the LCD materials industry necessitates a long-term perspective from top management. In fact, as many LCD material companies are engaged in a variety of products, they can bear the risk of investment for production and development of a specific product. This is a reason why top management of many LCD materials companies can maintain a long-term perspective.

Moreover, to accumulate the necessary technologies and knowledge, employee experiences are significant. Experience in production shops and laboratories is particularly important. Ultimately,

the accumulation of technology at various sites and a long-term perspective from management were appropriate for several Japanese companies that entered this industry.

Other experiences may create technological barriers. The cooperation between LCD materials companies and their customers can result in the competitiveness of Japanese LCD materials companies becoming stronger, which will be analyzed in detail.

Furthermore, considering that it takes time to accumulate technologies, the experience that LCD materials companies gained before entry into the market might have contributed to their success.

For example, Nitto Denko, a top polarizer maker, continued to manufacture varnish, a kind of electrical insulating material. Thus, the company was able to accumulate the technology to synthesize polymers and adhesive technology that could then be used to produce polarizer film for LCDs. Based on the accumulated technology to stress and paste together synthetic resins, Okura Industrial also entered the market for retardation film and polarizer film for LCDs.

In producing PVA, the technology required to form a thin layer with uniform characteristics is very important and the level of technology that customers, which are the LCD polarizer makers, require is high. Kuraray, the leading company of this market segment and a former textile company, accumulated the technology by integrating production from resin to film before entering the LCD polarizer market.

Asahi Glass accumulated core technologies through experience in manufacturing glass for construction and automobiles. In starting an LCD glass substrate business, the company used core technologies, such as the processing and design technology of glass materials, fluorine processing technology, and the technology for forming thin layers with surface treatment. ZEON and JSR used the technology for molecular control from experience in the synthetic rubber business to manufacture and develop retardation film and color register.

Further, Fujifilm developed TAC film for LCD polarizers using the technology of the base film for photos, which it had accumulated while in the photo business. The company used coating technology to form a thin layer with uniform characteristics, and organic synthetic technology, film deposition technology, and optical simulation technology to produce TAC film for LCD polarizers. Konica Minolta also used photo film technology to create TAC film for LCD polarizers. For example, the company used the technology to dry the metal plate that liquefies the resin film with a solvent, and then peeled the film to create a new product. This technology was accumulated with experience in photographic film production. Finally, Stanley Electronic Co. used the technology accumulated in the automotive lighting products business to manufacture the cold-cathode tubes for LCD backlights.

Indeed, some Japanese companies accumulated technologies and knowledge over time. Therefore, they were able to overcome the technological barrier to enter the LCD materials market and maintain their dominant positions in each market segment.

Additionally, there are other sources of competitiveness of Japanese LCD materials companies. For example, before the market segment was saturated completely, Japanese material companies attempted to find new emerging market segments and shift management resources using their accumulated technology. Furthermore, they changed market segments repeatedly if a new profitable market segment emerged.[11] This shows that Japanese materials companies have the capability to understand the change of future markets and the flexibility to shift between market segments. This flexibility is incorporated in the transaction behavior of the companies and includes both the market principle and the organizational principle. Therefore, I will examine the interfirm relationship of LCD materials companies, focusing

on the interaction between the market principle and the organizational principle.

2 COEXISTENCE OF THE MARKET PRINCIPLE AND ORGANIZATIONAL PRINCIPLE: COOPERATION WITH AND COST REDUCTION PRESSURE BY CUSTOMERS

2.1 Cooperation between Japanese Customers and Suppliers: The Organizational Principle

Japanese LCD materials companies and LCD companies have cooperated in various ways. First, they cooperated occasionally through the co-development of the customized materials needed for manufacturing LCDs.

In 1995, Fujifilm and its customer Sharp co-developed a new production method for optical film for LCDs: they developed the method to manufacture color photosensitive transfer film that was pasted to LCD glass substrates. With this new method, the film production process was much simpler and, as a result, it reduced production cost. In fact, Fujifilm introduced the method for mass production of the film in the spring of 1996. A very wide range of technology, such as film processing technology, optical analysis technology and coating technology is needed to develop the polarizing plates for large LCDs because it is essential to adjust the optical characteristics according to the structure of the LCD. As a result, the polarizing plate firms and LCD firms frequently co-developed materials and exchanged technological information.[12]

Sharp co-developed with suppliers to develop backlights, color filters and polarizing plates, working together from the early designing phases.[13] There are even cases of customers supplying material companies with technology related to the manufacturing of LCD materials. For example, in 1995 Seiko Epson actively supplied the suppliers of backlights, polarizing and color filters with technology related to cost reduction in manufacturing.

Moreover, firms cooperated in other ways. Some Japanese LCD companies encouraged LCD materials firms to establish their factories nearby. When Sharp established a new LCD factory in Kameyama City in the Mie Prefecture in 2002, it encouraged LCD materials firms to establish their factories in the vicinity of the Kameyama factory. Some LCD materials companies moved near the site of Sharp's LCD factory before it built the new LCD factory in Kameyama, and others moved after the new factory was constructed.[14] This cooperation illustrates the organizational principle in the transactions between Japanese LCD companies and LCD materials companies. The LCD firm customers probably expected the cooperation to reduce transportation costs and improve productivity. Moreover, they probably expected that it would be easier to exchange market information and technological information with suppliers. It is also highly probable that the cooperation had several positive effects on the LCD materials suppliers.[15] First, the cooperation with big customers resulted in stable orders for LCD materials even though the demand for LCD materials fluctuated. In addition, because the targets for development and production became clearer, the pace of material development and investment increased. Second, by keeping cooperative relations with specific big customers, LCD materials companies gained their trust and sales increased. Furthermore, this trust developed their reputation and they were able to expand sales to other customers.[16]

Third, the exchange of information between LCD materials companies and LCD companies increased, including technological information. As a result, LCD materials companies were able to accumulate technologies for high valued-added products and state-of-the-art production, as will be noted later, thereby increasing the sales of materials.

2.2 The Pressure to Reduce Costs from Customers and the Multi-source Policy: The Market Principle

While customers and suppliers of LCD materials cooperated closely, the materials

customers also put strong pressure on the LCD materials suppliers to reduce costs.

Along with the increase in LCD demand after the late 1990s, many companies entered the emerging LCD market from other industries. Thus, the competition among LCD companies regarding cost reduction and high quality became more intense. Specifically, competition for prices and product differentiation was intensified. As previously described, the cost of the material to manufacture LCDs was very high so reducing materials costs became more important to stay competitive. Eventually, LCD companies urged LCD materials manufacturers to reduce the cost of production.

Such strong pressure to reduce costs created a conflict of interest and strained the relations between customers and suppliers. This tension and conflict became apparent in the bargaining process of LCD materials transactions. This indicates the market principle. Hence, the cooperation shows the organizational principle and the conflict of interest demonstrates the market principle in the interfirm relationships of LCD materials transactions.

Moreover, interfirm relationships are not exclusive. LCD firms have a multi-source policy, purchasing the same materials from many suppliers. In other words, LCD firms made efforts to keep multiple materials companies as suppliers to create competition among suppliers. [17] For example, in the mid-1990s, LCD firms used many suppliers to disperse the risk of purchasing LCD glass substrates and color filters. Sharp's Kameyama Factory bought large-size LCD glass substrates from Corning as well as from Asahi Glass. In addition, Sharp produced color filters in-house and also bought them from Dai Nippon Printing (DNP) and Toppan. Consequently, DNP and Toppan competed fiercely to develop new production methods. In the sense that customers make use of the competition among the suppliers of LCD materials, a multi-source policy suggests the market principle.

3 THE INTERTWINING ACTION BETWEEN THE MARKET AND ORGANIZATIONAL PRINCIPLE IN THE INTERFIRM RELATIONSHIPS AMONG JAPANESE COMPANIES

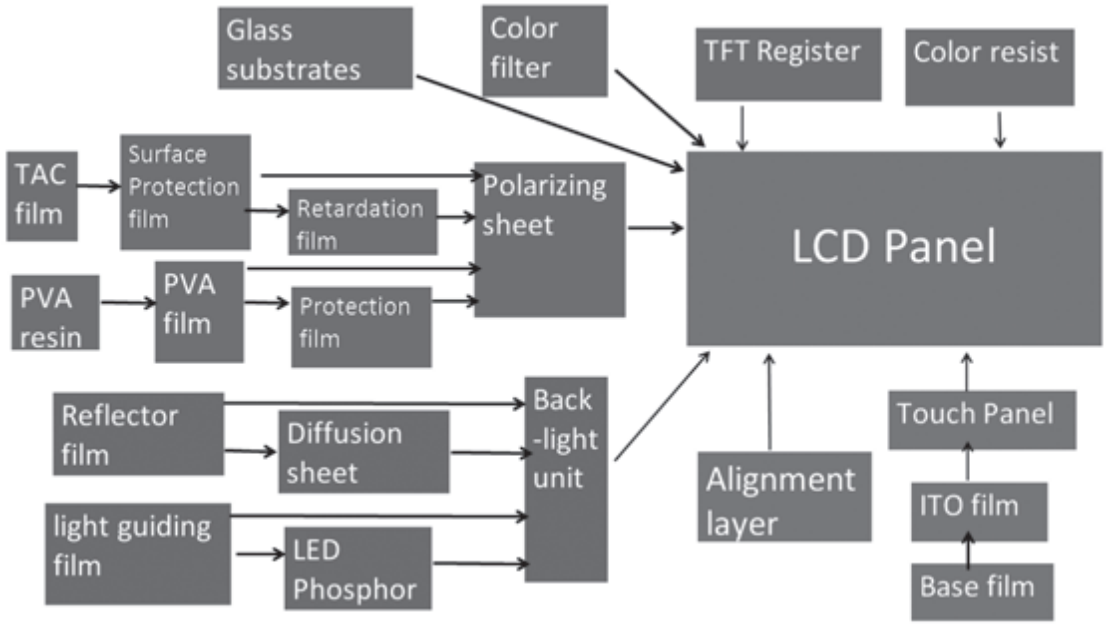
3.1 Technology Accumulation by Cooperation: The Organizational Principle

By repeated information exchange with big customers, LCD materials companies can accumulate technologies. According to Numagami's study,[18] co-development between Japanese LCD companies and LCD materials companies greatly contributed to advancing the technology and thereby establishing the technical capabilities of the Japanese materials companies. For example, in the early 1980s, Toppan practiced co-development with engineers of the central laboratory of Matsushita Electric Industrial to develop the color filter for video cameras. Ultimately, this co-development largely contributed to Toppan's success in the LCD color filter business.

Additionally, in the Japanese LCD materials industry, transactions of materials take the form of a chain(see figure 1). For example, while color filter firms were suppliers of LCD glass substrate, ITO film makers and LCD firms purchased registers as raw materials from Tokyo Ohka Kogyo, Toyo Ink, JSR, Intek, Hitachi Chemical and Fujifilm Hunt Chemicals. Then, register companies purchased dispersed pigments and sold registers to other LCD materials companies. Polarizing plates firms purchase PVA film and TAC film, but are also suppliers to LCD companies. Reflective polarization film makers purchase polyester and polyethylene terephthalate and sell reflective polarization films to backlight makers.

This chain of transactions in Japanese LCD materials contributes to the accumulation of technology.[19] In particular, any technological progress and improvement stimulates and accelerates the change in related technologies in the chain of transactions. For example, as the LCD size increased, the original form of the acrylic resin in the manufacturing diffuser plates for LCD

Figure 1 The chain of transaction between LCD materials



backlights warped due to the moisture. Therefore, the firms that manufacture the diffuser plates for LCD backlights had to change the resin to polystyrene.[20] This implies that the technological progress in the industry had various sources and progressed rapidly and widely. Similarly, investment by an LCD materials company stimulated other LCD materials companies through the chain of transactions. For instance, Kurarey and Nippon Gohsei, strong Japanese PVA film firms, actively sought capital investment in 2007 because their customer, Nitto Denko, invested in the expansion of production capacity. The chain of investment accelerated the increase in production and the progress of technology.

Furthermore, many LCD materials companies are simultaneously both customers and suppliers in the chain of transactions. Thus, LCD materials companies share the common interests of both suppliers and customers. Consequently, it seems likely that suppliers and customers of LCD materials would cooperate more easily and accelerate technology accumulation. This demonstrates the organizational principle.

The technology accumulation through the chain of transactions cooperating with customers is an important factor that increases the technology barriers to entry in this industry. Thus, this is an important source of strength for Japanese LCD materials companies. This demonstrates the organizational principle in interfirm relationships. Furthermore, it shows that the organizational principle may function positively for both parties in the transaction of LCD materials.

3.2 The Change in Bargaining Power in the Transaction of Materials: The Market Principle

On the other hand, the cooperation of suppliers and customers disadvantaged customers, although this was unexpected. In other words, cooperation between suppliers and customers weakened one party in the transactions for LCD materials. Specifically, the cooperation influenced the change in bargaining power in LCD materials transactions. Even with the cooperation, the interests of LCD firms and LCD materials firms

conflicted with each other, especially when negotiating for LCD materials. This illustrates that the cooperation between LCD firms and LCD materials companies, which shows the organizational principle, resulted in a negative effect on the customers in the bargaining process of transactions, which represents the market principle.

Take a closer look at the paradoxical phenomena. Since LCD materials manufacturers accumulated technology and knowledge through transactions with big customers, the technology barriers to entry in the LCD materials industry became higher, thereby strengthening the oligopolistic character of the industry. In general, in an oligopolistic market the behaviors of rival companies are clearly apparent. Accordingly, the companies can adjust the total supply of the industry more easily than in a competitive market. Furthermore, LCD firms had to depend on oligopolistic materials firms because it became very difficult to find other materials companies to purchase the same materials as a second source. Consequently, the bargaining power of Japanese LCD materials firms increased in the negotiations of LCD materials with big customers.

Indeed, in the initial phase of the LCD materials industry, the bargaining power of new materials firms was very weak in transactions with LCD firms because most LCD firms had big customers. LCD firms considered materials firms only as small subcontractors. For example, when Shinto Paint[21] entered the market for color film for LCDs in the mid-1990s, Toshiba, one of the big customers of LCD materials, outsourced only part of the color filter production process to Shinto Paint.[22]

However, primarily due to the accumulation of technological capability resulting from the cooperation with LCD firms, LCD materials companies strengthened their bargaining power in transactions of LCD materials. Although there is little direct evidence, indirect evidence can be acquired by comparing the price change of LCD materials with the prices of LCDs in the same period. In short, in a period of sluggish demand for LCDs, the LCD materials prices declined more slowly than LCD prices.

Specifically, LCD prices declined in the fall of 2004, although the price was stable after the recovery from the "IT recession" in 2002. Compared with the first half of 2004, the prices of LCDs for TVs in April 2005 decreased by about 50 percent. Even though LCD prices became stable in the spring of 2005, they fell sharply in 2006. The price of an LCD for a 32-inch and a 37-inch TV declined about 25 percent during the first half of 2006, and the price of an LCD for a 17-inch and a 19-inch PC fell about 30 percent during the same period. Due to the sharp drop in LCD prices, LCD firms suffered a drop in profits. Consequently, they urged the LCD materials firms to reduce the price of their products.

However, the drop in LCD materials prices was slower than for LCDs, although the prices of some LCD materials fell considerably. For instance, the price of LCD glass substrates declined about 10 percent during the first half of 2006. The price of Cold Cathode Fluorescent Tubes (CCFLs), which are used to manufacture LCD backlights, decreased slightly in the same period. Conversely, the price of PVA film, a material for manufacturing polarizing plates, increased.[23]

These examples show that LCD materials have a strong bargaining power in the transactions of each material. In comparison, LCD materials firms were considered to be small subcontractors in the initial phase of the LCD industry, and their bargaining power in the transactions of materials increased substantially.

However, this does not mean that they should not cooperate. Therefore, cooperation and conflict co-exist and are interrelated. In other words, the organizational principle and the market principle co-exist and are interrelated.[24]

4 THE INTERTWINING ACTION BETWEEN THE MARKET PRINCIPLE AND ORGANIZATIONAL

PRINCIPLE BEYOND NATIONAL BOUNDARIES

Japanese LCD materials firms have frequently transacted with many foreign customers since the early 2000s. As a result, the transactions of the materials are significantly internationalized even though the nationalities of customers are limited to Far East Asian countries, such as Korea, Taiwan and Japan.[25] Thus, the organizational principle and the market principle exist and are internationally intertwined in the transactions of LCD materials.

4.1 The Market Principle

The behavior of customers and suppliers, which illustrates the market principle, can be observed in the international transaction of LCD materials. Initially, Korean and Taiwanese LCD companies purchased the same materials from multiple suppliers. That is, they practice a multi-source policy similar to Japanese LCD firms such as Sharp. As a result, each materials company in the same market segment attempts to sell to the same customer simultaneously and competes fiercely to sell to foreign customers with whom they continue to have a good relationship. These phenomena illustrate the market principle.

For example, LG Display, a Korean LCD firm and strong rival of Japanese LCD makers, continued to purchase LCD glass substrates from Asahi Glass and Nippon Electric Glass simultaneously. A Taiwan LCD manufacturer purchased color filters from Sumitomo Chemical and Toppan. Moreover, Korean and Taiwan LCD firms that practice in-house production of color filters and polarizing plates also purchase them from Japanese materials firms. These examples are illustrations that LCD firms continue to make use of the competition among LCD materials suppliers, demonstrating the market principle.

Second, each Japanese LCD materials company established at least three different production bases, including multiple overseas production lines, to prevent them committing to a specific foreign customers too much. For instance, Nitto Denko and JSR established production lines in Taiwan, Korea and Japan.[26] Sumitomo Chemical dispatched engineers to overseas production bases in Taiwan and Korea. Additionally, the company practiced co-development with Taiwanese and Korean LCD makers to learn new technology related to the next generation of LCD panels. Asahi Glass has a production line near the LCD factories of Samsung Electronics and LG Display in Korea, as well as near the LCD factories of Taiwan LCD firms in Central Taiwan and Sharp's factory in Japan. Nippon Electric Glass has a LCD glass substrate production line in the LCD agglomeration districts of Samsung Electronics and LG Display in Korea as well as in Central Taiwan. These behaviors disperse the risk of depending on a specific customer by creating competition among suppliers.

In conclusion, customers and suppliers used competition of the other party of transaction each other. This demonstrates the market principle.

Third, LCD companies can change suppliers of materials if they create problems. For example, Chimei Electronic in Taiwan had purchased LCD glass substrates almost exclusively from Asahi Glass and suddenly changed their supplier to the Taiwan Factory of Corning, signing a long-term transaction contract in August 2004. This was largely because Asahi Glass failed to meet the delivery deadline for LCD glass substrates for production of the sixth generation LCD panel because of a quality problem in the production of glass products.[27] Although Japanese LCD materials firms can continue relations with specific customers, they are at the same time exposed to the threat of being replaced. This also illustrates the market principle.

Finally, since LCD companies in East Asian countries compete fiercely with each other, they are under pressure to deliver high-quality and low-cost materials. This also indicates possible conflicts of interest between Japanese LCD materials firms and foreign LCD firms. The pressure and conflict between customers and suppliers of LCD materials are evidence of the market principle.

There are other cases that show the conflict

between the suppliers and customers of LCD materials. For instance, when Japanese LCD materials companies established a production line near the factories of foreign LCD companies, most of the production lines concentrated on the post-processes.[28] Asahi Glass and Nippon Electric Glass Nitto Denko, JSR and Sumitomo Chemical have only post-processes in overseas factories.

With regard to the manufacturing of LCD materials, post-processes are less important than pre-processes, even though the former are also important in terms of cost. This is due to materials firms fearing that information about the core technology of their materials products and manufacturing might be leaked to foreign customers. This indicates a conflict of interest between Japanese materials companies and foreign LCD companies.

4.2.The Organizational Principle[29]

There are behaviors in the international transaction of LCD materials that demonstrate the organizational principle.

Above all, many Japanese LCD materials companies have production lines in LCD agglomeration districts in South Korea and Taiwan in accordance with their customers' requests. In Korea, where the world's top LCD makers Samsung Electronics and LG Display are located, Japanese firms of LCD glass substrate, color filters, polarizing plates and CCFL for backlights have production lines in the agglomeration district of LCD production.[30] For instance, Samsung Electronics invited Sumitomo Chemical to their LCD factory in Pyeongtaek to manufacture color filters and polarizing plates. In addition, Asahi Kasei Chemicals also has a production line of LCD diffusers and light-guiding plates for LCD backlights in this factory.

Since the early 2000s, Asahi Glass has had polishing process lines of LCD glass substrate in LG Display's LCD factory in Kumi City. Nippon Electric Glass also founded an LCD glass substrate manufacturing company as a joint venture with LG Display in 2005. The company built a post-process line of LCD glass substrate in LG Display's LCD factory in Paju City and began production of LCD glass substrate for the seventh generation LCD in February 2006.

Moreover, Japanese LCD materials companies built factories in 2000 when the Taiwanese LCD industry started in earnest, although they did not intend to supply specific LCD firms. Along with the construction of the industrial district in Central and Southern Taiwan in the late 1990s, many Japanese LCD materials firms established production lines.

In Southern Taiwan, several Taiwanese LCD makers moved to the "Science Park" that was established by the regional government and the Chimei Business Group in 1999.[31] Soon after, some Japanese materials companies, such as Toppan and DNP, also established a manufacturing base for color filters in the park as a joint venture. Furthermore, they carried out technology transfers to Taiwan and production outsourcing to the local materials companies. Sumitomo Chemical began manufacturing LCD polarizing plates in the park in a joint venture with SC-IK Technology, a local polarizing plate maker. Chisso established a production base for LCD materials in the park as well.

There are also science and industrial parks and Japanese LCD materials manufacturing facilities in Central Taiwan. For example, Nitto Denko, which had a manufacturing base in Central Taiwan, started producing LCD polarizing plates in the science park in 2005. Asahi Glass started producing LCD glass substrates in Central Taiwan's industrial park in August 2000, and Nippon Electric Glass had production facilities of LCD glass substrates in the region. JSR founded the JSR Micro Taiwan as a subsidiary company in Taiwan and began the mass production of color register in 2006.

Furthermore, Taiwanese LCD manufacturers and Japanese LCD materials companies cooperated. Some Taiwanese LCD firms invested in the Japanese

materials firms. For instance, AU Optoelectronics (AUO), a first-rate Taiwanese LCD firm, invested money in the Taiwanese subsidiary company of Toppan that specialized in manufacturing color filters by buying 37.9 percent of the issued stock. The investment by AUO strengthened the cooperative interfirm relationship between AUO and Toppan, especially in terms of technology.

Cooperation like this strengthened the competitiveness of materials companies. Indeed, based on the cooperation with Samsung Electronics, Sumitomo Chemical increased its sales of acrylic plates for LCDs. Furthermore, since high quality products in each materials market segment are supplied only by a few Japanese LCD materials companies, they supported the foreign LCD companies. These examples of cooperation between Japanese LCD materials firms and foreign LCD companies demonstrate the organizational principle beyond national boundaries and that it interacts with the market principle.

CONCLUSION

In the interfirm relationship between Japanese LCD materials companies and LCD companies, the organizational principle works. First, they cooperated occasionally through the co-development of the customized materials needed for manufacturing LCDs. Second, some Japanese LCD companies encouraged LCD materials firms to establish their factories nearby. Third, the exchange of information between LCD materials companies and LCD companies increased, including technological information.

By the cooperation, LCD materials companies were able to accumulate technologies for high valued-added products and state-of-the-art production. As a result, barrier to entry in this industry become higher and the oligopolistic structure gets harder. Eventually Japanese LCD materials companies became stronger in the market.

In addition, before the market segment was saturated completely, Japanese material companies successfully attempt to find new emerging market segments and shift management resources using their accumulated technology. This flexibility, which implies both the market principle and the organizational principle, is also other source of strong competitiveness of Japanese LCD materials companies.

On the other hand, the market principle works as well in the interfirm relationship in this industry. For example, the cost of the material to manufacture LCDs is very high so reducing materials costs became more important to stay competitive. Eventually, LCD companies urge LCD materials manufacturers to reduce the cost of production. Such strong pressure to reduce costs creates a conflict of interest and strains the relations between customers and suppliers. In particular, the tension and conflict become apparent in the bargaining process of LCD materials transactions. This pressure and conflict demonstrate the market principle. Moreover, LCD firms made efforts to keep multiple materials companies as suppliers to create competition among suppliers, which implies the market principle.

Again, the market and the organizational principles are intertwined. Specifically, the cooperation between LCD firms and LCD materials firms which represent the organizational principle weakened one party of the transaction for LCD materials, which represents the market principle. For instance, since LCD materials manufacturers accumulate technology and knowledge through transactions with big customers, the bargaining power of Japanese LCD materials firms increased in the negotiation of LCD materials with big customers. In sum, due to the accumulation of technological capability through the cooperation between suppliers and customers of LCD materials, the suppliers, LCD materials companies strengthened their bargaining power in transactions of them and created the potential conflicts of interest.

At the same time, as Japanese LCD materials firms have frequently transacted with many foreign

customers since the early 2000s, the transactions of the materials are significantly internationalized. It illustrates that the organizational principle and the market principle in the transaction of LCD materials internationally work and are intertwined.

In new industries such as this LCD materials industry, interfirm relationships were globalized in the early phase of the industry. As a result, The behaviors of individual companies that cannot be expressed in terms of their "Japanese-ness" will become more important as transactions increase among companies of different nationalities. The specific characteristics of interfirm relationships in each country will be less important in the future, especially within the context of globalization.

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[1] This article is the revision of the paper that was submitted to the annual conference of ISA, Industry Studies Association in Minneapolis on May 25, 2016.

[2] In this article I define the concept of the organizational principle in a rather broad sense. That is, I define the organizational principle as that which is used by economic actors in order to control the market mechanism intentionally and actively.

[3] The interfirm relationships between suppliers and customers were significant to the development of Japanese steel, machine tool and IC industries. Furthermore, as will be described later, in the interfirm relationships of the LCD materials industry, the market principle and the organizational principle coexist and are interrelated, which is similar to the Japanese steel, machine tool and IC industries(Kim(2015)).

[4] For example, Sako(1992).

[5] For example, see Hakansson (1982); Hallen (1986).

[6] Triacetate cellulose is typically used for the creation of fibers and film base, and is widely used in the manufacturing of the polarizing plates for LCDs.

[7] *Gekkan Monthly Kagaku Keizai* [*Monthly Chemical Economy*].

[8] This characteristic is different from that of the LCD industry.

[9] JETRO, *Japan Economic Monthly*, November 2005.

[10] *Nikkei Business*, 15 November 2004.

[11] Kim (2014).

[12] *Nikkei Elekutoronikusu*, 22 May 2006.

[13] *Electronic Journal*, September 2006 and *Nihon Keizai Shimbun*, 17 June 2005.

[14] Kim (2007). When Sharp constructed new LCD production bases overseas, some materials companies established their LCD materials production lines to supply Sharp's overseas factory.

[15] Since the investment in specific customers may result

in increased risk, LCD materials companies have to find ways to reduce the risk.

[16] This effect is very similar to that seen in ICs for consumer appliances. In the market for ICs for consumer appliances, if top consumer appliance companies captively consumed ICs to be developed and produced for themselves, owing to their brand power in consumer appliances, the IC chip gained a good reputation among other consumer appliance companies. This made it easier to expand sales of ICs in the market for ICs for consumer appliances.

[17] Multi-source policy by customers and cooperation between suppliers and customers can also be observed in the Japanese steel and IC industries. This illustrates that intermediate goods industries share the market principle and the organizational principle.

[18] Numagami (1999, Chapter 11).

[19] Kim (2006). The chain of transactions has negative effects on some Japanese companies as well. For example, because some materials companies are sandwiched between forward and backward members of the chain, their bargaining powers become weak and their businesses are deemed unprofitable.

[20] *Nikkei Sangyo Shimbun*, 19 January 2006.

[21] Shinto, a paint manufacturer, is an affiliated firm of the Sumitomo business group and began its color filter business for LCDs in January 1992. Several other paint manufacturers, such as Japan Paint, entered this industry almost at the same period. In the color filter market segment, firms with various backgrounds, like electronic parts and printing firms, set up and continued in business. Thus, the number of companies in color filters for LCDs is larger than those in other LCD materials market segments. Accordingly, it is rather difficult to call the market segment of color filters for LCDs an oligopoly. In that sense, the color filter market segment is an exception in the LCD industry.

[22] *Nihon Keizai Shimbun*, 6 April 1994.

[23] *Nihon Keizai Shimbun* and *Nikkei Sangyo Shimbun*.

[24] In general, the intertwining of the market and organizational principles does not guarantee any particular effect. In other words, the intertwining may lead not only to positive effects but also to negative effects on the specific industry. In that sense, its effect could be multi-faceted. It implies that it will be needed deeply to examine the intertwining between the market and organizational principle in interfirm relationship of various industries.

[25] It is interesting to consider why the LCD and LCD materials industries are concentrated in this region. So far, there have not been any studies supplying an answer to this question.

[26] Corning has LCD production lines in Korea, Japan and Taiwan.

[27] *Nikkei Sangyo Shimbun*, August 2005 and 3 September 2005.

[28] *Nikkei Microdevices*, January 2006. However, there are a few cases where LCD materials companies established pre-process production lines in their overseas factories (*Nikkei Microdevices*, April 2003).

[29] Yoshimoto and Shintaku researched the cooperation between optical drive makers and optical pickup makers across borders of countries in East Asia (Yoshimoto and Shintaku, 2005). Therefore, international cooperation in the transactions of intermediate goods is very popular and not exceptional.

[30] *Nikkei Microdevices*, June 2005 and February 2006.

[31] *Nikkei Microdevices*, April 2006.