

THE DEVELOPMENT OF INTERNATIONAL R&D NETWORKS IN THE ELECTRONICS INDUSTRY. A LONGITUDINAL APPROACH

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ABSTRACT

Asian manufacturers lead the world markets in the liquid crystal display (LCD) and plasma television set industry. The competitive strengths of Japanese, South Korean and recently emerging Chinese firms may be founded on their network-based strategic concepts. We, therefore, apply a network perspective to analyze international R&D activities in the electronics industry and describe how these networks have evolved during the last two decades. We applied a snowball-procedure to generate knowledge about all relevant players in the market and their R&D connections to other firms and analyzed the developed networks both qualitatively and quantitatively.

Our findings indicate that the firms' networking intensity has been increasing in recent years, which underlines the importance of the network approach in international business. Additionally, we found that Panasonic and Sharp, which reached the highest networking scores, simultaneously represent the technological market leaders in the LCD and plasma television set markets respectively, thus delivering support for the relevance of the firms' integration in R&D networks. Overall, our findings provide strong implication for theory and business practice.

Key words: R&D networks, Asian firms, consumer electronics, international joint ventures, network evolution

INTRODUCTION

Japanese, South Korean, and recently emerging Chinese firms lead the worldwide markets in many technologically driven consumer electronics segments, for instance in the liquid crystal display (LCD) and plasma television industry. While Japanese firms started their business expansion in Europe during the 1970s, the global development of the South Korean electronics industry over the last two decades is even more impressive since it was achieved, relative to Japanese competitors, in a much shorter period of time. The dominance of Asian players in this market might even increase in the future if Chinese, Taiwanese and Indian manufacturers, are able to gain further market shares around the globe. All in all, Asian-based electronics manufacturing has thus significantly increased its market shares worldwide over the last decades, while Western competitors lost market shares accordingly (e.g., Philips, Thomson, and Grundig).

One possible explanation for this development is the network-based strategy of the Asian firms in the market. The case of LCD panel manufacturing demonstrates the relevance of those R&D driven industry-specific networks. With just eight (Samsung, Sharp, Panasonic, Toshiba, LG Electronics, Hitachi, AU Optronics, and Sony) technologically leading LCD panel manufacturers worldwide, this industry is characterized by network architecture. For example, Samsung allies with Sony, while Sony allies with AU Optronics and Sharp. Sharp agreed upon alliances with Toshiba and Fujitsu. LG Electronics cooperates with Toshiba, while Toshiba agreed upon several alliance relationships with Panasonic which cooperates with Hitachi. Thus, all competitors are connected in a complex network structure. In the light of this phenomenon, we apply the network perspective to analyze international R&D activities.

Theories of internationalization describe the firm's internationalization process. In contrast to traditional concepts (Johanson and Vahlne, 1977), the network perspective draws particular attention to the social and cognitive ties that are formed between actors (individuals and organizations) engaged in international business (Björkman and Forsgren, 2000, Hohenthal, 2001). The network approach which serves as the theoretic basis for this paper developed over time.

At the beginning, the literature concentrated on characteristics of buyer-seller relationships with an emphasis on issues related to power and control (Easton, 1992). This initial concept, which concentrated on relationships in retailing and distribution functions, became known as the interaction approach, and is usually identified since the late 1970s with the work of the European IMP (Industrial/International Marketing and Purchasing) research group (Tikkanen, 1998). The interaction approach evaluates long-term dyadic relationships between buyers and sellers of manufactured goods in different countries (Hakansson, 1982, Hakansson and Ostberg, 1975, Ford et al., 1986). Because of the relatively narrow focus on dyadic inter-organizational activities, the interaction approach is to be considered separately, thus cannot be interpreted as a first stage of the network approach (Easton, 1992).

In the corresponding literature, network concepts launched in the mid of the 1980s and amplified research towards system-wide aspects of industrial networks instead of isolated dyadic institutional connections. In comparison with the interaction approach, the industrial network approach considers that a relationship cannot be managed in isolation from other relationships and, thus, represents a conduit to other relationships through which resources may be accessed (Tikkanen, 1998, Andersson, 2002, Easton, 1992). As a result of perpetually evolving research within the last decades, diversifying streams within the context of network research developed, which to some extent differentiate and simultaneously, intermingle, with each other.

The first batch of scholars interprets the ‘network as an industrial system of organizational-interdependent relationships’. The ‘industrial system’ is composed of firms indirectly and directly engaged in supply, production, distribution, and service with other entities including competitors. Firms embedded in these industrial networks are linked to each other through long-lasting relationships that develop complex inter-firm information channels which cause mutual interdependencies of the involved participants (Mathews, 2002, Johanson and Mattsson, 1988, Ritter, 2000, Ritter and Gemünden, 2003, Ritter et al., 2004).

The second segment within the network internationalization literature is devoted to the phenomenon of ‘new venture’ and ‘born global’ firms. Scholars particularly emphasize aspects of ‘learning through networks’, which help to internationalize more rapidly than in the past. Due to a lack of previous or fixed routines in entering foreign markets, ‘new ventures’ or ‘born globals’ combine their own resource disadvantages (e.g., lack of foreign market

knowledge or internationalization experience) with the potential of other network partners, for example through alliance and joint venture engagements (Sharma and Blomstermo, 2003, Gabrielsson and Kirpalani, 2004, Freeman et al., 2006).

The third group of scholars punctuates networks as ‘social grids’ which consist of individuals (e.g., entrepreneurs, managers, employees, customers). People are connected by social relationships within a bounded population which forms a social network (Björkman and Kock, 1995). Personal contacts and social interaction with individuals in the external environment influence the internationalization path of the firm, especially where complex industrial products are concerned (Axelsson and Easton, 1992, Ellis, 2000). Competitive advantages in the global marketplace are particularly fostered by the entrepreneur, who is often but not necessary the founder and business owner (Zahra, 2005). Internationalization is a reflection of time based-behavior, specific to individual entrepreneurs as participants and managers of social networks (Jones and Coviello, 2002, Coviello and Jones, 2004, Zahra and George, 2002, DiGregorio et al., 2008, McDougall and Oviatt, 2000)

The evaluation of networks within the context of international relationships is methodologically enormously complex, and is, therefore, difficult. Previous criticisms of the network theory of internationalization are derived from rather general empirical insights that reflect a momentary spotlight of the industry environment but do not consider appropriately the industry-specific details, such as supplier-customer-competitors relations and its reconfiguration over time (Gulati et al., 2000, Andersen and Buvik, 2002, Johanson and Vahlne, 2003). The paper aims to overcome this research gap and conceptual weakness through its longitudinal research approach in the consumer electronics industry and describes how these networks have evolved during the last two decades. This article is positioned in line with the major aim of the network approach, which does not primary target a prescription; rather, the goal is description and understanding of network patterns and evolution processes (Salmie, 1996). Due to particular characteristics in the electronics industry, such as research intensity, the need for component standardization, and short-lived technology cycles etc.; the derivation of general legitimacies tends to be risky. Nevertheless, empirical conclusions at the end of this paper invite for further research activities in other industries which may allow more generalized interpretations and, thus, contribute to the further development of the network concepts in the future.

FOUNDATIONS OF A NETWORK

A network can be viewed in general as a model or metaphor that describes a number of entities that are connected (Axelsson and Easton, 1992). The network concept encompasses a firm's set of relationships, both vertical and horizontal with other entities. Vertical networks are cooperative grids, including relationships across industries and countries, between system and component suppliers, manufacturers, and merchandisers, often established to mutual strengthen their research and development (R&D) efforts, improve production efficiency, market research expertise and sales performance (Windeler, 2005, Gulati et al., 2000). Horizontal networks are cooperative engagements of firms located in a similar industry with comparable value added activities. Thus, horizontal networks often include the cooperation of competitors and therefore, tend to be partially cooperative and to some extent competitive. In the electronics industry, horizontal relationships in R&D between firms which are simultaneously competitors are not seldom and of particular importance in order to jointly set new technological standards. For example, Sony agreed to a 'blu-ray disk technology alliance' with its competitors Apple, Dell, and Hitachi, which, in 2008, succeeded in competing with the high definition DVD alliance of Toshiba, Microsoft, and Intel (Faigle, 2008).

In the case of international industrial networks, the entities are actors involved in the economic process that converts resources into finished goods and services. The network model is based on the assumption that a firm's changing internationalization situation is a result of its positioning in a network of firms and their connections to each other (Zuchella and Scabini, 2007). Consequently, a network is depicted as systems of social and industrial relationships among various parties which support or hinder a firm's performance in international business. Networks form the basis of effective communication, thus providing firms with the opportunity and motivation to internationalize. Relevant information disseminates via interaction of the involved participants (Ellis, 2000). The nature of relationships influences the strategic decisions of the participating firms (Coviello and Munro, 1997, Welch and Luostarinen, 1988). Cooperative agreements in networks range from long-term oriented contractual relations in the fields of R&D, strategic component procurement and contract manufacturing; as well as various licensing and cooperative arrangements such as strategic alliances, and joint ventures (Mathews, 2002, Müller-Stewens and Lechner, 2005, Hitt et al., 2003).

Due to global competition forces, an increased flow of information and financial capital around the globe, and accelerating technological development, product life-cycles are significantly shortened in the electronics industry relative to the past decades. For instance, the mass market sales of liquid crystal display (LCD) technology used in television sets was launched in 2004 in Europe. In 2007, more LCD sets (26 million) were sold than conventional devices with cathode ray tube technology (10 million sets); thus within only three years, to some large extent, LCD replaced the color ray tube technology, which dominated the industry during the 20th century (Glowik, 2009). Simultaneously, there is a tendency for an enlarged number of firms to be rapidly internationalizing (i.e., TCL China). This trend accelerates R&D efforts which come along with the necessity to grant more resources for a higher R&D budget, thus increase the return on investment risk for the firm. Confronted with significantly shortened product life-cycles and increased competition intensity, it is assumed that some firms seek to maintain competitive advantages through intensified networking activities focused on R&D while other firms may ignore the benefits of being a part of a network.

METHODOLOGY

Preface

Gulati et al. (2000) suggest that the network perspective provides an interesting platform for evaluating the positions of firms in the industry network. The network view provides insights into the dynamics as firms and industries evolve over time and explain why some firms get locked-in and why others get locked-out of the market.

However, research on industry networks tends to be complex and results run the risk of misleading interpretations, particularly if the empirical study targets a short period of research time. This research gap initiated the incentive to develop a longitudinal study targeting the evaluation of an industry network evolution during the period 1995-2008.

A first step was taken in the year 2004, when pre-research activities were done in order to evaluate whether it would be empirically worthwhile to initiate the project and to conduct a feasibility study. In addition to a content analysis of relevant market and industry data (i.e., company annual reports, industry market surveys, and firm related information material), five industry-expert interviews using the Delphi method, each interview lasting around one hour,

were carried out with former employees of Samsung SDI. The Delphi technique served as an assessment of the impact of emergent trends on both the European television set product market and the Asian firms involved (Craig and Douglas, 2000, Berekoven et al., 2001). The pre-study results showed an increasing intensity of networking activities, through joint ventures and alliance agreements, by Asian firms in recent years, particularly in the field of R&D.

As a consequence the study was continued and in 2005 the main research period was initiated and launched. The main part of empirical study lasted from 2005 until the beginning of 2009.

Sample and Data Collection

The aim of our study was to provide the most comprehensive analysis of R&D network structures in the television set industry possible. We applied a snowball-procedure to generate as much knowledge about all relevant players in the market and their connections to other firms. We, thus, started with one firm and analyzed its past and actual R&D-alliances in the industry, the content of those alliances, and the development of those alliances over time. As a next step we then went on to the alliance partners of this firm and did the same.

We conducted field interviews between July and September 2007. Based on a semi-structured questionnaire, one Internet-based and fifteen face-to-face interviews in Germany and South Korea were completed. Interviews normally lasted between one to one and a half hours and were done with current and former executives (ownership, management and senior staff level) of Samsung Electronics, Samsung SDI, LG Electronics, LG.Philips Displays, Simon Gisul Co. Ltd., Cheil Industries Inc., Veseg GmbH, and TCL-Thomson Electronics. The interviews provided in-depth insight into the industry and its networks. The semi-structured interviews were performed based on pre-formulated questions. The sequence of the questions was rather flexible, and the respondents were free to talk and give their opinions (Zou and Ghauri, 2008). This format allowed adaptability in the topics (R&D, networking) that developed during a conversation and flexibility in pursuing further insights related with the firms' network engagements depending on the interviewee's answers (Atteslander, 2003). There were two criteria for the selection of appropriate interview partners. First, they had to be familiar with the corresponding network engagements of the firms selected for this study; and second, they had to be familiar with the television manufacturing industry environment.

In a next step, a broad range of secondary sources were collected and analyzed in addition to the interviews, such as companies' annual reports, press releases, and various kinds of corporate information including enterprise presentation materials and data from market research institutes, for example 'GfK Nuremberg'.

Then, we developed in-depth case studies on each actor in the network. We applied this multiple in-depth firm case study method since we believe in-depth case studies, through intensive qualitative analysis, serve best for describing the multiplex nature of network relations. Due to the complexity of the research topic, quantitative variables concerning the network evolution in the electronics industry are hard to operationalize adequately for the present status of research (Yin, 2003). Furthermore, the use of case research provides a richness and depth of understanding about the network evolution that is hardly achievable with survey data (Eisenhardt, 1989, Coviello and Munro, 1997).

Analysis based on secondary data demonstrates that the firms selected represent the driving industry forces and the most important brands on the market. According to the data the firms selected jointly accumulate a market share of around 80 percent in Europe (2008), which underlines the representativeness of sample.

Data analysis

Following the concepts of network analysis by Tichy et al., (1979) and Wassermann and Faust (1994), adjusted to the topic of our study, a network analysis was performed.

As a first step, we analyzed the development of *network size* over time. The network engagements of LG Electronics, Panasonic, Philips, Samsung, Sharp, Sony, and TCL China, from each firm's perspective, agreed during the period 1995 until 2008, were collected and reported in table 1.

=====INSERT TABLE 1 ABOUT HERE=====

As can be seen in table 1, the number of newly agreed network relationships increased from 3 engagements (1995) until 9 (2008). However, the amount of newly agreed R&D network

engagements did not increase linearly each year similar as a forward-directed expansion process pattern. The pattern of newly engaged network appointments seems to resemble a cyclical process with ups and downs of newly agreed relationships.

The second half of the 1990's indicates a decreasing trend of networking activities. This might be explainable by relatively stable market surroundings within this period. From the European market perspective, sales of televisions set increased up to 36 million in 1998 (1990: 28 million) and the cathode ray tube represented the dominating technology (DisplaySearch, 2008).

However, maybe as an effect of the Asian financial crisis (Chang, 2003), and corresponding difficulties of firms involved, the number of newly agreed network engagements in the television set industry increased until 2001, followed by a network consolidation process until 2005. From the year 2005, the network activities significantly increased again until 2007. The technological substitution of the cathode ray tube technology by newly upcoming technologies such as liquid crystal display and plasma, might have caused, that firms increasingly approached partner firms in order to bundle their resources, particularly in the fields of R&D. In 2007, 26 million liquid crystal display television sets were sold relative to 10 million cathode ray tube television units. Sales forecasts indicate an increase up to 38 million liquid crystal display television sets for 2011 relative to marginal 0.5 million cathode ray tube television sets in Europe. These figures underline the market dynamics in the electronics industry and may help to understand the trend of intensified joint R&D activities. In addition to the increased networking intensity as a possible response to technological reasons as explained above, it becomes questionable, how the networking behavior may accelerate in the near future as a result of the current worldwide economic crisis. The size and the network development for the period 1995 until 2008 is visualized in figure 1.

===== INSERT FIGURE 1 ABOUT HERE =====

After analyzing the growth of R&D networks in the industry, we now focus on the content of the network relationships and therefore the *intensity* of network relations (e.g. Tichy et al., 1979). As an outcome of the contents analysis and the corresponding field interviews it was found that the cooperating modes in R&D, thus the intensity of networking engagements between the firms do not indicate a uniform pattern. We found three different types of R&D

relationships in our study: ‘strategic component supply’, ‘joint R&D’, and ‘shared R&D, manufacture, and distribution’ as quantified in table 2 for the period 1995-2008.

===== INSERT TABLE 2 ABOUT HERE =====

The first category ‘strategic component supply’, represent rather loose relationships between firms, usually established through long term oriented contractual agreements which, however, can be terminated easily. ‘Strategic component supply’ describes a form of relationship where the involved parties agree upon common material procurement, and/or technical standardization and/or guarantee the mutual supply of strategic sensitive components. Securing component supply is of vital importance when the demand is higher than worldwide production capacities. The second category ‘joint R&D’, describes shared efforts in component development in order to speed up new product launches or to set up a new technological standard. The third category, ‘shared R&D, manufacture, and distribution’, outlines a trend in the television set industry since 2001. Firms not only join their R&D efforts but transfer the research results to joint manufacturing and sales/distribution (usually with different brands).

Nevertheless, advantages in experience curve effects and economies of scale due to shared R&D, manufacture, and distribution needs to be balanced against the risk of mutual dependencies and severe consequences for each participating firm if the project fails. Therefore, it is assumed that the forms of bilateral network relations such as ‘strategic component supply’, ‘joint R&D’ and ‘shared R&D, manufacture, and distribution’ have a fundamentally different impact for each firm involved. For example, ‘strategic component supply’ agreements can be initiated and terminated within a relatively short period of time and, thus, represent a rather disengaged form of relationship between firms. In contrast, ‘shared R&D, manufacture, and distribution’ usually has crucial resource consequences for the participating firms, and a project failure has severe effects on the financial performance of the partner firms.

Therefore, network weighting parameters were included that consider the intensity of the relationships for the firms involved. We operationalized the bilateral network intensity with index values from 1 to 3.

- (1) Strategic component supply [value: 1]
- (2) Joint R&D [value: 2]
- (3) Shared R&D, manufacture, and distribution [value: 3]

Following the processes of quantifying the network activities of the firms examined in the course of qualitative research and the inclusion of the weighting parameters, we carried out an analysis that yields an index rate. The total index rate takes into account both the frequency of the network activities and the intensity of the selected network modes for each firm. As result, the overall network intensity, and consequently, the overall positioning of a firm as a major or minor player in the network (**centralization**) is deduced. For example, Sharp agreed to 12 bilateral relations between 1995 and 2008, divided among the networking categories as follows: category (1) ‘strategic component supply’, 3; category (2) ‘joint R&D’, 4; and category (3) ‘shared R&D, manufacture, and distribution’, 5. The number of each network category is multiplied by the corresponding value parameter and the results allow the determination of the total index rate of each firm (in case of Sharp 26). The total index rate then allows the firms to be compared and ranked, thus deducting the network intensity and each firm’s position in the network (centralization; table 3).

===== INSERT TABLE 3 ABOUT HERE =====

Based on the evaluation of the index rates, it can be concluded that Sharp (index 26) and Panasonic (index 23) are intensively involved in television set industry networks and are, thus, central players of the network. Interestingly, both Japanese firms hold the leadership position in their technological segments. Panasonic is the designated leader in plasma television and Sharp in the liquid crystal display technology.

As the final step of our analyses, we now combine the previously developed measures to describe the development of R&D-networks over time. This network evolution of the television set industry, which simultaneously visualizes the development of two opposing

technology hubs, Sharp (liquid crystal display) and, Panasonic (plasma technology) is illustrated for the years 1997, 2001, 2005, and 2008 in Figure 2 to Figure 5.

===== INSERT FIGURE 2 TO FIGURE 5 ABOUT HERE =====

The illustrations show clearly, that Sharp and Panasonic did not develop their network grids ‘overnight’, their central position in the network is to be seen as a long-term oriented process of network building where these firms had been actively involved over years. Based on the total index rate, it can be concluded that the LCD and plasma market leaders, Sharp and Panasonic respectively, are intensively involved in industry networks, while Philips, despite its relatively active networking, has significantly lost importance in the television set industry. Of course, the Dutch firm still belongs among the top brands in the European market. However, Philips’ involvement in R&D as well as in vertical manufacturing stages related to television set assembly has declined in recent years. For example, the equity joint venture of Philips and LG Electronics for joint R&D, manufacturing and distribution of liquid crystal displays (‘LG.Philips LCD’) was established in 1999. Over the years of the venture operations, Philips has continuously reduced its financial engagement and just held a joint venture stake of 13.2 percent in March 2008. One year later, in March 2009, Philips sold its remaining stake in the world’s second-biggest flat-screen maker. Finally, Philips Electronics NV ended its 10 years stake partnership with LG Electronics (Kim, 2009).

LG Electronics, which was in severe financial difficulties before the joint venture partnership with Philips was founded, has continuously strengthened its position during the venture operations. The South Korean firm recovered financially and gained access to European marketing expertise as well as distribution channels through its partner firm, Philips.

‘TCL-Thomson Electronics’, another important European-Asian joint venture in the television set industry, established in 2004, was terminated just three years after the venture foundation, in 2007. As a result, the television set operations of Thomson has been absorbed by TCL China, which significantly strengthened TCL China’s market position through additional trademark rights, several R&D centers around the world, and access to various patents. Furthermore, the illustrations of the network evolution (figures 2 to figure 5) allow a more in-depth interpretation of the time-based analysis conducted beforehand.

NETWORK PARTNER SELECTION AND NETWORK REPOSITIONING OVER TIME

As found in the analyses above, Sharp and Panasonic show intensive network activities. A further research outcome indicates that Japanese firms prefer network engagements with partners from their home country. In the case of Panasonic, a total of nine network engagements in the form of joint ventures or alliance agreements have been found within the research project. Among them, six agreements were signed with Japanese firms, one with a Chinese firm, and two with European firms. Sharp has been involved in a total of twelve partnerships, among them eight commitments with other Japanese firms and one each with a Chinese, Taiwanese, German, and an U.S.-based firm. The network engagements of Japanese firms mainly focus on shared R&D, manufacture, and distribution of the partner firms. Major alliance targets are, for example, bundling technological know-how through joint research and development, and sharing investment risks concerning common manufacturing plants. Interestingly, the European market leaders of the 1990s, Thomson and Philips, have never cooperated with each other in order to defend against the powerful competition from the Far East.

According to the interview outcomes of the South Korean electronics industry experts, cost competitiveness and technological leadership are the main strengths of the Asian television set manufacturers in relation to European firms. However, Asian firms rather lack European marketing skills and strong local brand awareness. Thus, it is assumed that bilateral network relations between Asian and European firms tend to combine diversified resource strengths and weaknesses, which cause another reason of network instability, relative to intra-Japanese alliances which mainly join their R&D efforts (concentrated resource strengths).

The cases of Fujitsu, which handed over completely its LCD business to Sharp in 2005, and Pioneer, which transferred its complete plasma operations to Panasonic in 2008, indicate that Japanese firms cooperate to bundle strategic resources in their home country. Avoiding the risk that technological know-how is lost to foreign enterprises; the competitively weaker Japanese firm transfers its resources, particularly valuable R&D knowhow, including patents, to the surviving Japanese firm, through a 'cooperative agreement'. 'Alliances' between Japanese firms seem to be used on purpose because this avoids that a foreign firm takes advantage of know-how through the acquisition of a Japanese firm.

Similar to Taylor et al. (2000), the results of the empirical case studies indicate that Japanese enterprises tend to maintain long-term oriented business relations. Japanese firms often cooperate on a number of common joint venture projects with selected partner firms. If a joint venture is ended, because for example the market for the corresponding products is no longer there, the cooperation is continued in another project. Panasonic, for example, founded a joint venture with Toshiba in the area of color picture tube manufacture in 2003. In 2006, after the previous cooperation was terminated and the production stopped because the color picture tube sales on the worldwide markets went down, a new joint venture was founded between the two Japanese firms for LCD and organic light emitting diode (OLED) technology. Panasonic agreed upon a joint venture with Hitachi in 2004 concerning shared R&D, manufacture, and distribution of LCD modules. The cooperation between Panasonic and Hitachi was 'renewed' and continued in 2008 (shared R&D, manufacture, and distribution of LCD modules in the Czech Republic) (Matsushita, 2008).

Sharp, for example, made an agreement with Sony in 1996 for the joint development of flat screen panels. In 2008, the joint project was 'renewed' when both Japanese firms started their common LCD panel manufacturing activities. In 2000, Sharp agreed to an alliance with Pioneer for the joint development of 'next generation digital products'. One year later, the cooperation was expanded through the alliance of Sharp and another joint venture with Tohoku-Pioneer targeting R&D, manufacture, and sales of substrates for organic displays next generation products (Sharp, 2007).

Joint ventures between Japanese firms follow a certain pattern that is characterized by the mutual wish of contingency over time to create a 'win-win situation'. The long-term time horizon allows partner firms to build up mutual trust and helps to overcome the short-term venture difficulties that come up during the partnership. Experiences collected in one previous joint venture project improve organizational issues and the corresponding business performance of the next venture operations. In contrast, the Chinese TCL could not rely on experience from previous cooperations with the French Thomson, similar as Philips and LG Electronics. Language and cultural challenges contributed to the venture instabilities.

Japanese firms make sure the joint venture management does not operate separately and too independently. The venture management usually shares the decision power and is integrated

into each parent's firm structure and long-term strategic plans. In contrast, the relationships between TCL China and Thomson as well as LG Electronics and Philips started with the philosophy of a 'partnership of equals'. However, the Asian joint venture partner incrementally took over the decision power and the venture operations were terminated within a relatively short period of time.

The long-term approach, similar cultural background and language skills, mutual trust through experience from previous joint projects, and the combining of mutual R&D resources serve as the basis for the competitive advantages in the global market of the Japanese firms in the television set industry. In the course of international networking, Japanese firms had synchronized their R&D and manufacturing advantages, e.g., total quality management, and 'kanban' philosophy, (Chen, 2004). It can be concluded that the Japanese firms have established a strong television set industry base with corresponding narrowly knit firm clusters. Stable relationships between firms and bundled R&D resources result in innovative, qualitative and cost-competitive products, which provide the basis for successful business activities in Europe and other regions around the globe.

IMPLICATIONS AND LIMITATIONS

Andersen and Buvik (2002) recommended longitudinal studies in order to gain detailed industry-specific knowledge about the potentials of networks in international business. Similarly, McDougall and Oviatt (2003), proposed further empirical research in order to develop existing network concepts. This paper aims, through its detailed industry case studies, and its longitudinal approach, to contribute to the current research gap. As a result of the empirical study of the network dynamics in the consumer electronics industry the following implications are summarized.

First, it can be concluded, that the firms' networking intensity has been increasing in recent years, which underlines the importance of the network approach in international business. The research results allow deducing reasons of increased networking intensity in the television set industry, in the field of R&D, due to shortened technology, and product life-cycles, which come along with higher investment costs and accelerated market dynamics. Practitioners from other industries may use this example to forecast future developments in their industry.

Additionally, this relevance of networks also has strong implications for research. It questions the applicability of dyadic entry-mode concepts to industries with strong network engagements. Future studies should thus test for the relevance of networks before selecting an appropriate research design.

Second, the research delivered further interesting results in this respect: Panasonic and Sharp, which reached the highest networking scores, simultaneously represent the technological market leaders in the liquid crystal display and plasma television set markets respectively. Thus, these firms serve as a benchmark with respect to an ‘absorptive learning capability’ (Grant, 1996, Zuchella and Scabini, 2007) because they benefit from networking advantages with other firms, but obviously without losing sensitive know-how, which would threaten their technological market leadership. Thus, future research may further explore the relevance of absorptive learning capability in networks.

Third, European firms such as Philips, Grundig and Thomson which played a major role in the television set industry during the 1990’s have been largely locked out from the television set industry networks. European manufacturers (e.g., Grundig went bankruptcy in 2004, Thomson terminated the television set production) are replaced by Japanese and upcoming South Korean and Chinese firms which incrementally locked in the network in recent years. This underlines the relevance of network-engagement for firms in the electronics industries. Additionally, research may further explore the institutional underpinnings that affect the network integration of firms from different contexts.

Fourth, while Japanese firms, for the most part, target their networking activities on joint R&D, the European-based Philips, mainly contributed marketing-based resources (e.g. brand name, access to European distribution channels) to their network engagements. Simultaneously, Philips looked for R&D know-how and lowering their manufacturing costs, for example through the partnership with LG Electronics. LG Electronics (similar as the case of TCL China and Thomson) incrementally took over the venture decision power, and absorbed valuable marketing expertise. Finally, the venture operations were terminated. Thus, it might be assumed, that R&D know-how and manufacturing cost advantages outpoint marketing assets. Further research may focus on the partner firm’s diversified resource input in Asian-European joint ventures and its impact concerning the venture control over time. This may contribute to the current literature themes of control mechanism and partner’s

bargaining power in international joint ventures (Yan and Gray, 2001, Makino et al., 2007, Lin, 2005, Lu and Xu, 2006) .

Fifth, the number of network engagements obviously correlates with uncertainties in the market. The outcomes of the Asian financial crisis (2000) and the technology substitution of the mature cathode ray tube technology by the liquid crystal display technology (2006); each caused a significant increase of networking activities. This provides interesting alleys for future research on this issue.

Sixth, the complexity of firm connections has amplified. As illustrated for 1997 (figure 2), the industry actors maintained rather dyadic/portfolio relationships which, passing an evolution process, have transferred to connected relations/network (Ritter et al., 2004) as illustrated in figure 5 for the year 2008. Future studies may compare these findings with developments in other industries.

Besides those strong implications, qualitative research through the case study method has limitations and generalizations of the research outcomes tend to be risky. Furthermore, every case study is influenced by a subjective interpretation of the enterprise because of an outsider's view of the researcher (Schmid, 2006). However, despite its limitations there is, from the authors' perspective, no better empirical concept than qualitative research through case studies, with regards to the research aim, which targets the description of network structures over time (longitudinal study). The firms selected for the study, such as LG Electronics (and its joint ventures with the European enterprise Philips), Panasonic, Samsung, Sharp, Sony, and TCL China (and its joint venture with the European firm Thomson), secure representativeness of the random sample and the research outcomes respectively.

The authors emphasize that above research outcomes are based on a longitudinal study in the electronics industry. Thus, the derivation of general legitimacies for other industries is limited. For that reason, the authors invite for further empirical study regarding the network evolution in other business segments. The results hopefully may verify the conclusions discussed above and thus provide a wider acceptance of the findings of this research which leads to a further development of the network theory.

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Tables

Firm	Year														
	95	96	97	98	99	00	01	02	03	04	05	06	07	08	Total
LG Electronics	0	0	0	0	1	0	1	0	0	0	0	1	2	1	6
Panasonic	1	0	0	0	0	0	1	1	1	1	0	1	1	2	9
Philips	1	0	1	0	1	0	1	0	0	0	0	1	2	2	9
Samsung	0	0	0	0	0	0	1	0	0	1	0	0	1	0	3
Sharp	1	1	0	0	0	1	2	1	0	0	1	1	2	2	12
Sony	0	1	0	0	0	0	0	0	0	1	0	0	1	1	4
TCL China	0	0	0	0	0	0	0	1	0	1	0	1	1	1	5
Total	3	2	1	0	2	1	6	3	1	4	1	5	10	9	48

Table 1. Development of R&D related network engagements from each firm's perspective in the television set industry (1995 until 2008). Source: collected by the authors through evaluation of various kinds of firm related documents (content analysis)

Year	Network engagements in the television set industry segmented by R&D intensity			
	Strategic component supply	Joint R&D	Shared R&D, manufacture and distribution	Total
1995	0	0	3	3
1996	0	2	0	2
1997	0	0	1	1
1998	0	0	0	0
1999	0	0	2	2
2000	0	1	0	1
2001	2	2	2	6
2002	2	0	1	3
2003	0	0	1	1
2004	0	0	4	4
2005	0	0	1	1
2006	4	0	1	5
2007	5	0	5	10
2008	2	1	6	9
Total	15	6	27	48

Table 2. Network engagements in the television set industry segmented by R&D intensity. Source: Authors

Firm	Firm Network Engagements	Category (1) Strategic component supply $ni(1)=n*[1]$	Category (2) Joint R&D $ni(2)=n*[2]$	Category (3) Shared R&D, manufacture, and distribution $ni(3)=n*[3]$	Centralization Index $t_{ni} = \sum ni(1-3)$
Sharp	12	3=3*1	8=4*2	15=5*3	26
Panasonic	9	2=2*1	0	21=7*3	23
TCL China	5	3=3*1	0	6=2*3	9
LG Electronics	6	2=2*1	0	12=4*3	14
Philips	9	3=3*1	2=1*2	15=5*3	20
Samsung	3	0	2=1*2	6=2*3	8
Sony	4	1=1*1	2=1*2	6=2*3	9

Table 3. Network centrality segmented by firms in the television set industry and their network engagements for the period 1995 - 2008. Source: Authors

Figures

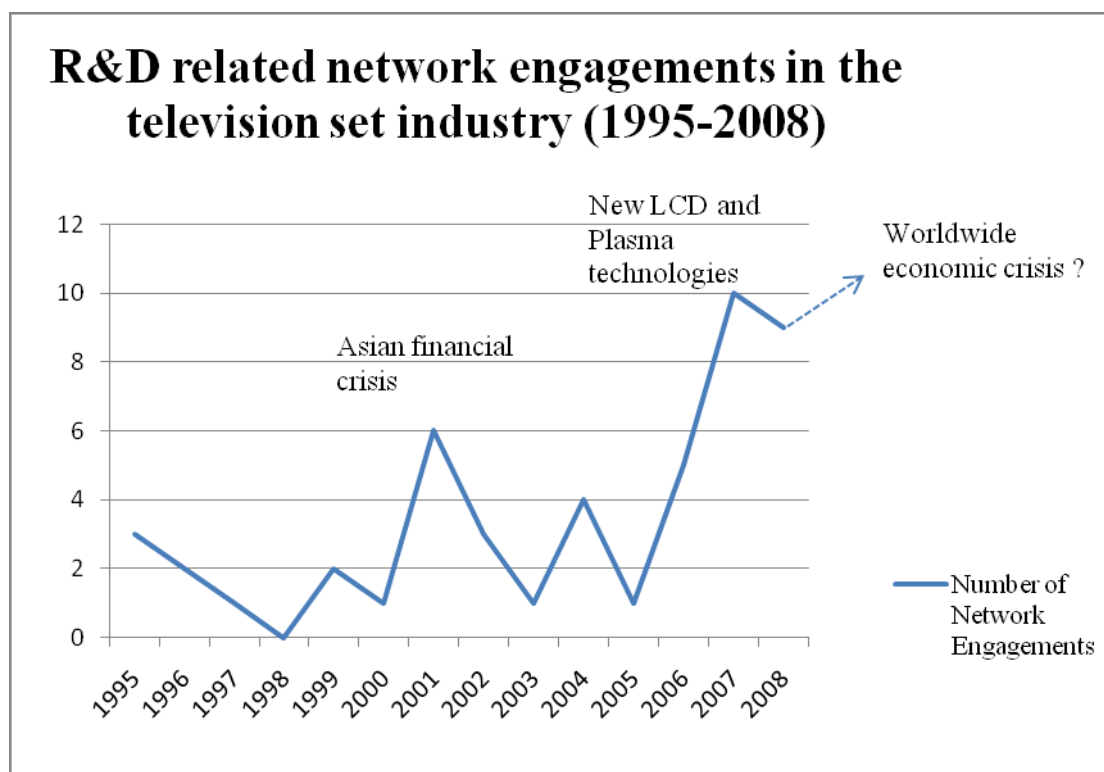


Figure 1. Visualization of the development of newly agreed R&D related network engagements in the television set industry for the period 1995 until 2008. Source: collected by the authors based on an evaluation of various kinds of firm related documents (content analysis)

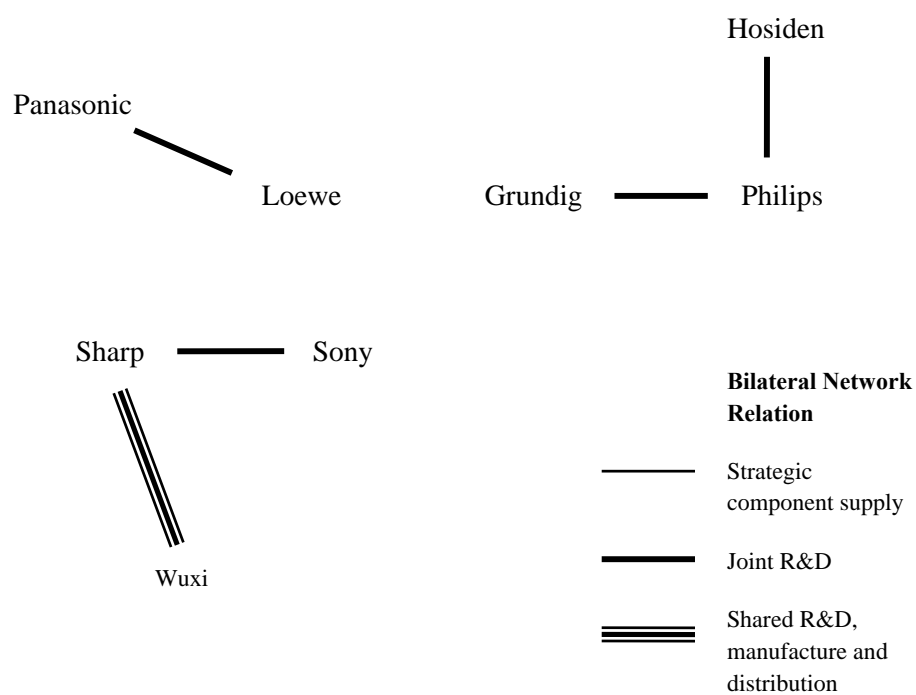


Figure 2. Network status 1997. Major players operating in the television set industry. Source: Authors

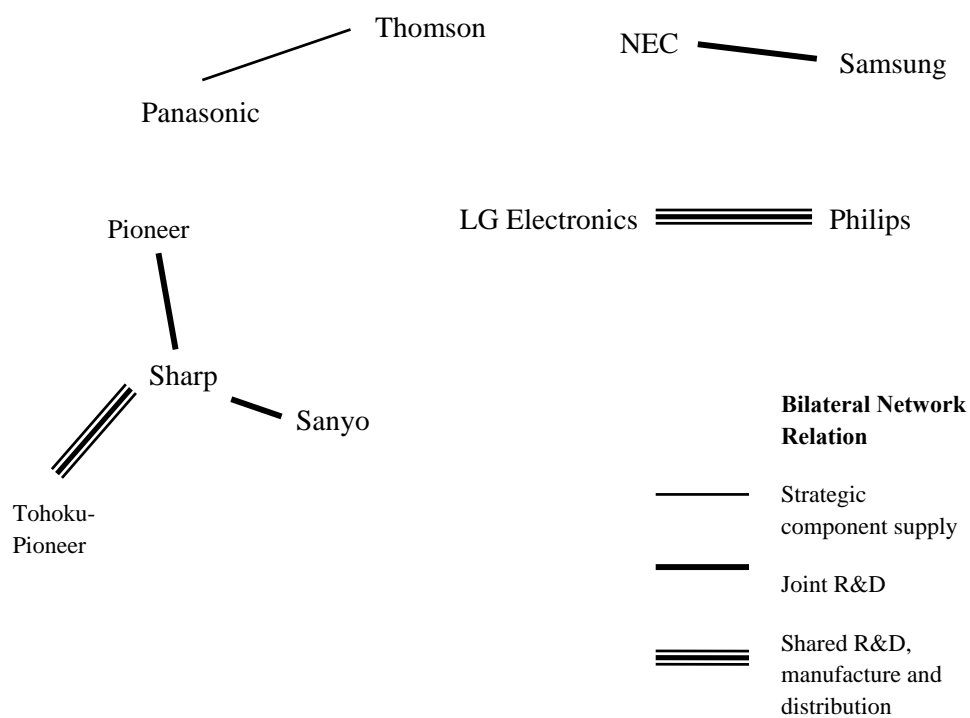


Figure 3. Network evolution 2001. Major players operating in the television set industry. Source: Authors

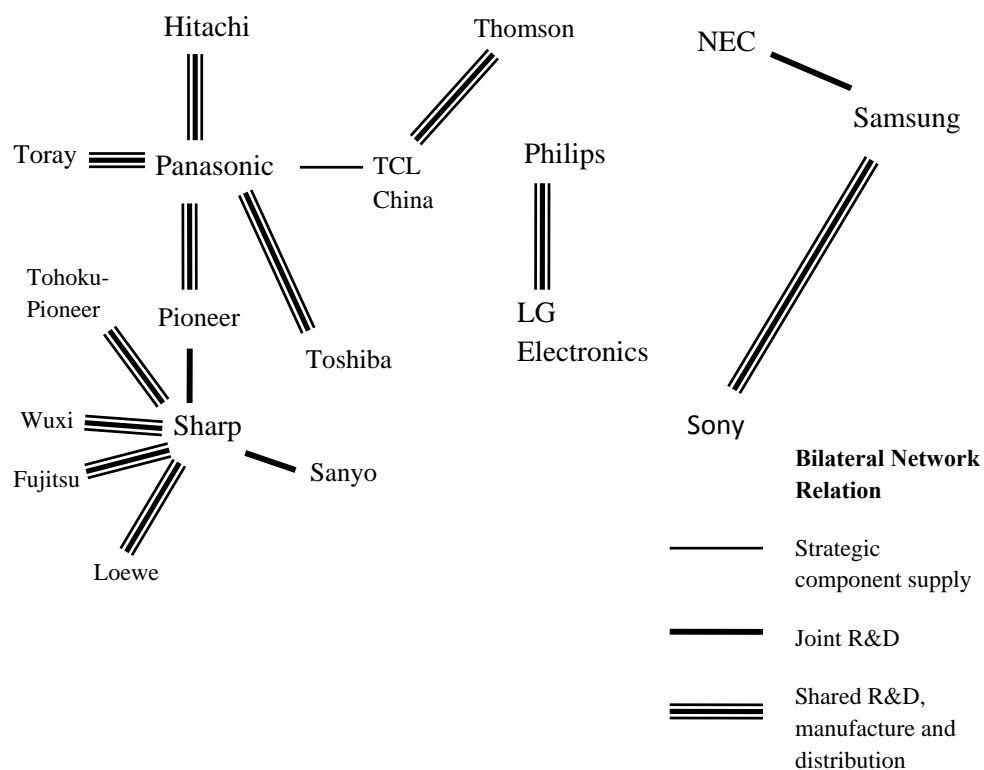


Figure 4. Network evolution 2005. Major players operating in the television set industry. Source: Authors

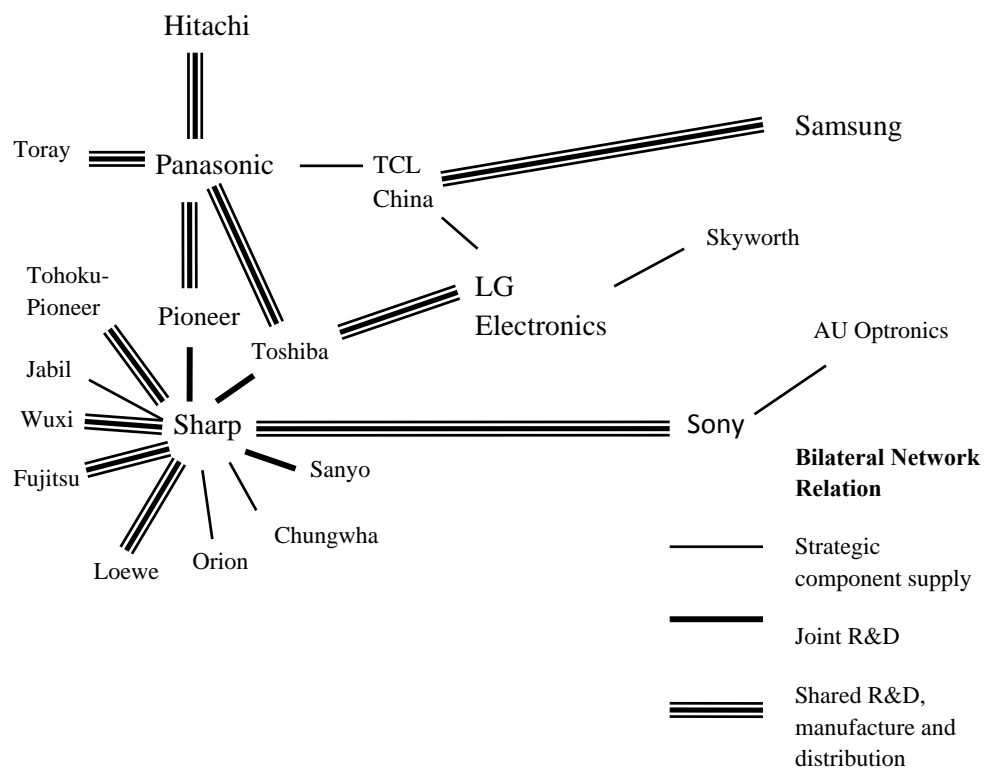


Figure 5. Network evolution 2008. Major players operating in the television set industry. Source: Authors