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Competitive-*cum*-Cooperative Interfirm Relations and Dynamics in the Japanese Semiconductor Industry

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Preface

This book is the cumulative outcome of several projects. My interest in the semiconductor industry started when I was involved in a United Nations University project titled "Japan's Self-reliance in Science and Technology for National Development." The late Professor Toshio Shishido, then the Vice President of the International University of Japan, generously included me in the project as a young scholar along with prominent Japanese specialists in technology and development.

My interest in institutional analysis began when I was invited to be visiting assistant professor at the University of Wisconsin-Madison in 1987. I am grateful to Professor Solomon Levine for providing me with such a rare opportunity. There I met Professor Rogers Hollingsworth, who introduced me to the fascinating field of institutional analysis and to a group of top-level scholars working in the field. Inspired by institutional analysis, I began to develop the conceptual framework needed to identify the institutional dynamics of Japanese high-technology industries. Grants from the International University of Japan (1989) and the Japanese Ministry of Education (1990-1991) enabled my colleagues and me to start the project. My role was to investigate the semiconductor industry; Professors Shinichi Watanabe and Ichiro Inukai of the International University of Japan were to inquire into bio-related industries. They gave me invaluable assistance by teaching me an economist's perspective and enriching my conceptual framework. Later, small grants from the Kajima Foundation (1992) and IBM Japan (1993) enabled me to continue research on the semiconductor industry. Travel grants from the International University of Japan (1993), the Nomura International Foundation (1994), the Murata Science Foundation (1996), and the Japan Foundation (1996) have enabled me to pursue and present this research.

In conducting a survey and interviews, I am deeply indebted to the late Professor Saburo Okita, the former Foreign Minister and President of the International University of Japan, for his human dignity and his sincere un-

derstanding of young scholars. He opened many doors to facilitate interviews with prominent businessmen and to conduct the company surveys. Also greatly appreciated is the assistance offered by several top-level managers of Japanese semiconductor companies for allowing me to conduct research. Needless to say, I am especially thankful to the twenty-nine managers in the seven semiconductor companies who cooperated with me. Without their patience and expertise, this research would not have been possible.

My conceptualization of competitive-cum-cooperative governance has been advanced through the "Comparison of Capitalist Economies" project organized by Professor Rogers Hollingsworth. My work has benefited from criticism by Professor Richard Whitley of the University of Manchester Business School, who commented on my paper in the capitalist-economies project.

The theory of competitive-cum-cooperative interfirm governance presented in this book is the outcome of the intellectual stimulation that I received from friends, company managers, and many scholars with whom I interacted. Ms. Ellen Jane Hollingsworth, the former Research Director of the Mental Health Research Center, the University of Wisconsin-Madison, and Professor Richard Whitley have given me valuable comments on this manuscript. Fr. Robert Ballon and Ms. Yasuko Hamabata of Sophia University have consistently provided me with valuable assistance when I most needed it: during the Advanced Development Management Program and the last stage of editing this book. I am grateful to Ms. Lisa Schreibersdorf for correcting my English and Mr. David Gear and Mr.Carlos Roberto Salas for assisting me at several stages of completion of this manuscript. Of course, none of them is responsible for the content or for any errors.

I am grateful to the Ministry of Education for providing me with a Grant-in-Aid for Publication of Scientific Research Results and to the Japan Society for the Promotion of Science for administering the grant.

My deepest appreciation goes to my family members. My wife, Hideko, and my children, Mika and Erina, have been silently and patiently supporting this book project. They did not complain about many days and long hours of work, even when my work spoiled joyful family plans. Our dog, JJ, often lessened my fatigue by showing her joy and by sleeping at my feet during many late nights.

Yoshitaka OKADA
Madison, Wisconsin
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Introduction

In the era between World War II and the early 1990s, a drastic transformation in the world's division of industrial labor took place. The recovery of West German industries, the rise of Japanese industrial capabilities, the rapid catch-up of newly industrialized economies (NIEs), the high growth rates of Southeast Asian countries and China, and the relative decline of U.S. international competitiveness changed the world's industrial power configuration. The distribution of industrial power in the world became increasingly multi-polar, which created unprecedented international competition among developed countries and NIEs. Developed countries, facing constant threats from other developed countries and from rapidly approaching NIEs, searched for avenues to strengthen or maintain their international competitiveness by developing highly sophisticated technologies and by swiftly transforming their domestic industrial structure. Questions were constantly raised by government officials, businessmen, and scholars as to how international competitiveness in high technology industries could be maintained or enhanced. Their attention was not limited only to types of management or technology, but was extended to include institutional arrangements.

Japan has often been the focus of this inquiry, since it has succeeded in enhancing its industrial capability at a very rapid pace. Its nominal GDP grew from US$15.7 billion in 1953 to US$4,190 billion in 1993, and its nominal GDP per capita increased from US$181.1 to US$33,701 (Kokusai Rengo, 1963:493; United Nations, 1979:137; Keizai Koho Senta, 1995:11). And since the middle of the 1970s, it has shifted its efforts toward enhancing high technology industries.

The semiconductor industry is a good example of this successful transformation. Despite U.S. leadership in semiconductor technologies in the 1950s and 1960s, Japanese success in developing a very large-scale integrated circuit (VLSI) in l977 enabled Japan to dominate the area of dynamic-random-access memory (DRAM) integrated circuits (ICs) and to gradually

strengthen its competitiveness in other areas of semiconductors (Okada, 1989a, 1989b, 1990).

In the 1980s, Japan came to dominate the 64K (70% in 1982), 256K (90% in 1984), and 1M (90% in 1988) bit DRAM world markets (Denpa Shinbunsha, 1983-1989; Press Journal, 1985). As the number of DRAM makers in the U.S. declined from fourteen in 1970 to three in 1986, the Japanese world market share of all types of semiconductors first came close to the U.S. in 1985, then grew even bigger in 1987 (Japan=48% vs. U.S.=39%), and peaked in 1988 (Japan=about 51% vs. U.S.=about 37%) (Department of Defense, 1987; Denpa Shinbunsha, 1988; Nihon Denshi Kikai Kogyo Kai, 1994:3). Among the top ten semiconductor producers in terms of sales, Japanese companies dominated the top three positions (NEC, Toshiba, and Hitachi) and three other positions in 1988 (Denpa Shinbunsha, 1989). Such success not only generated trade disputes between the U.S. and Japan, but also came to influence some U.S. innovation systems.[1]

The Japanese world market share, however, declined a little below the U.S. with the revitalization of the U.S. semiconductor industry and the advancement of Korean companies in 1993 (Nihon Denshi Kikai Kogyo Kai, 1994:3). The top semiconductor sales position went to a U.S. manufacturer, INTEL, while a Japanese company, NEC, retained the second position (Denpa Shinbunsha, 1995:843). For the first time, a Korean company, Samsung, came to lead the sales of 16M bit DRAM in 1993 (Press Journal, 1994:164) and occupied the seventh position in the sales of semiconductors (Denpa Shinbunsha, 1995:842). Although the golden age of the Japanese semiconductor industry (1977-1992) seems to be over, Japanese companies still maintain technological leadership in DRAM and diverse other semiconductor areas.[2]

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[1] Learning from the Japanese experience, the U.S. Government recognized the importance of cooperative research among private companies, previously considered a violation of the Anti-Trust Law. The National Cooperative Research Act passed in 1984 legalized cooperative research, and allowed the government and the private sector to create cooperative ventures. For example, the Defense Department and the private sector jointly established SEMATEC, while a number of companies cooperatively established the Microelectronics and Computer Technology Corporation (MCC) and the Semiconductor Research Corporation (SRC).

[2] Finan and Frey (1994) term the period between 1960 and 1984 the golden age of the Japanese electronics industry and identify 1984-1991 as a declining period. The Japanese semiconductor industry shows a delayed cycle. The golden age started when the VLSI cooperative succeeded in developing 64K-bit DRAM in 1977 and continued as long as Japanese companies kept leadership in the world market share. It ended in 1992 when they came to share the top position in the world market with U.S. companies.

How did the Japanese semiconductor industry achieve its dynamics? Many management theories attribute the success of Japanese dynamics to measures that promote cooperation and trust in intra- and interfirm relations (Gerlach, 1989; Inoue, 1985; Stowsky, 1989; Nakatani, 1984; Uekusa, 1987; Kinzley, 1991; Iwata, 1977, 1982, 1984). Is cooperation and trust sufficient to explain such dynamics? To make cooperative relations dynamic, isn't it necessary to make some use of stringent measures, such as introducing competition among cooperating members?

The Japanese achievement in the DRAM market was largely indebted to the success of a cooperative research association for developing processing technologies necessary for very large scale integration (the VLSI Cooperative). With financial sponsorship, the Japanese Government succeeded in obtaining cooperation among big semiconductor and semiconductor-manufacturing-equipment producers.[3] Undeniably, interfirm cooperation among competing companies and between companies of complementary specialization was one of the crucial factors that allowed Japanese companies to take the world leadership in the DRAM area.

Japanese companies cooperate with others over management, finance, technology, production and R&D. Such practices are well known and include the following complex programs and processes: cooperative quality assurance programs; value analyses and engineering to reduce costs by analyzing many different facets of production and process technology, products, inventory, marketing, etc.; plans and strategies for reducing prices (strategic pricing) that are jointly developed among long-term partners; and just-in-time production (JIT). R&D is often jointly conducted to maximize gains from the know-how of partners; sometimes organizations even make use of the same computers in designing and drawing (simultaneous engineering). In order to develop the capability of small- and medium-sized partners, large-sized companies often provide necessary inputs, management and technical training, and financial assistance.

Even in the sales activity of semiconductor companies, a key to winning in severe market competition is shifting from simple market-oriented activities, to becoming a cooperative partner on projects by suggesting diverse ideas and sharing information. The former approach was effective in the 1970s, but these days it often leads to a losing battle. Finding suppliers is determined in much earlier stages. In 1992 about 50% of a sales person's

[3] Cooperation is understood as joint or collaborative behavior directed toward some goal based on common interest and mutual expectations.

visits were, in an estimate, to the product development and engineering sections of a company, and the proportion has increased significantly since then to about 70% in the middle of the 1990s. Such competition in the early stages of product development requires developing a strong sense of cooperation with the personnel in charge of planning, product development, designing, and engineering.

There is abundant evidence that Japanese interfirm relations are a very important source of generating dynamic development in the semiconductor industry. And cooperative behavior is becoming a very important factor in deciding who wins in the marketplace. It is, however, difficult to understand how cooperation works as the key factor for explaining interfirm dynamics. What is often hidden within cooperative tactics is competition generated by cooperative activities or competitive measures that help cooperation to be dynamic. Without competition, cooperation itself might not contribute to interfirm dynamics.

Within the VLSI cooperative, what is known as parallel research was taking place in each company. At the same time that researchers from competing semiconductor companies cooperated under the joint laboratory of the VLSI cooperative, each company established a special research team within its own laboratory, and duplicated all research activities taking place in the joint laboratory as quickly as possible.[4] Since all competitors equipped themselves with the same advanced technological capability, competition took place among semiconductor companies over which company would develop a new product most quickly. A cooperative environment enabled the producers to share technological information, stimulate innovation, and raise technological capability. But cooperation itself stimulated competition over the speed of product innovation using the shared advanced technology. In addition, each producer's introduction of products based on similar technological sophistication further stimulated market competition (Okada, 1999). Competition was taking place behind cooperation.

Similarly, most of the practices in interfirm cooperation involve diverse stringent measures to make those practices work effectively, though they undeniably require a strong sense of cooperation and coordination. For example, cooperative quality assurance programs require a high standard of quality. Any supplier failing to meet the standard is penalized by losing some part of its orders to other suppliers. Value analyses and engineering actually involve bonus payments to outside companies, and suppliers are

[4] Interview with Company Q manager.

monitored on how they seriously engage in these activities. Strategic pricing requires a strong sense of cooperation to reveal the detailed cost information to an outside company, and failure to do so and comply with a pricing plan results in a penalty or the termination of the business relationship. These cooperative practices are actually accompanied by monitoring, evaluation, penalties, or even the termination of the relationship. Cooperative practices are actually accompanied by some measures to introduce competition. Conversely, as the example of semiconductor sales suggests, competition can be the motivation behind cooperation; severe market competition compels sellers to develop cooperative relations, shifting the focus of competition from marketing to cooperative behavior.

Market efficiency, understood as generating a maximum total value of outputs from any given set of inputs (Shepherd, 1997), can be achieved through both allocative and non-allocative efficiency. Allocative efficiency is accomplished by allocating resources to maximize the output and non-allocative efficiency is determined by other factors such as developing group dynamics, soliciting commitment, and stimulating motivational drives. Allocative efficiency can be most effectively achieved by introducing competition and rewarding a winner. The market is the best known mechanism for harmonizing transacting actors to achieve allocative efficiency, but it is incapable of attaining non-allocative efficiency. In contrast, non-allocative efficiency is usually achieved by promoting cooperation and appealing to an individual's motivation. A single organization can be effective in bringing about a very high level of cooperation and stimulation to individuals, but it is quite weak in generating allocative efficiency.

Long-term relations are in many cases developed between two independent companies, hence influenced by the allocative-efficiency-achieving market mechanism. Yet, they involve cooperation and diverse cooperation-promoting measures that enable them to achieve non-allocative efficiency. They can involve practices to increase both types of efficiency by both creating a cooperative environment and introducing competition to cooperative relations or making use of market competition. This is the unique and dynamic mechanism of long-term relations. Neither market nor an organization can generate such dynamics by itself. In other words, the dynamics of Japanese companies' behavior cannot be understood in terms of either the intrafirm operations of suppliers, assemblers, and distributors or arm's length transactions. A significant part of their success should be attributed to the development of long-term interfirm relations.

These long-term relations involve at least some sense of cooperation and cooperative activities, since repeated interaction generates benefits like re-

duction in transaction costs and the mutual sharing of information and know-how. But developing long-term relations does not mean that interacting companies are not operating based on the rules of market competition. Responding to changes in corporate environments, a company can modify cooperative relations with a partner by introducing uncertainty and threat or even terminating the relationship. It can make use of market competition to influence the nature and characteristics of cooperative relations. Companies in developing long-term relationships have a range of options: to increase the degree of cooperation, to introduce severe competitive environments among cooperating partners, or to pursue a combination of these two strategies. In other words, long-term relations can delicately mix cooperation and competition. Then, how do such interfirm relations contribute to the dynamics of the Japanese semiconductor industry? This is the basic question pursued in this book.

Semiconductor companies, usually large in size, interact with diverse types of business partners. One category consists of intrafirm members, for example, semiconductor manufacturing units interacting with company-wide procurement and sales sections, research laboratories, or other manufacturing units within the company. Second, semiconductor producers interact in long-term relationships with two types of companies: some are large-sized with equal power and bargaining positions vis-á-vis semiconductor manufacturers, while some are small- and medium-sized and have less power and an inferior bargaining position. Interaction may also be with companies in the spot market, with little prospect for continued business transactions. Business transactions in the semiconductor industry take place in roughly four functional areas: (1) parts and material procurement, (2) manufacturing-equipment procurement, (3) sales, and (4) R&D. Each transaction may involve any of the four different types of partners. For example, a semiconductor manufacturing unit can purchase parts and materials from other manufacturing units of the same company, or from long-term suppliers (small-, medium-, or large-sized), or from companies operating in the spot market. This typology of partners also applies well to R&D. Many companies conduct internal R&D, and long-term partners engage in joint R&D. But technology and know-how can also be acquired by one-time transactions with an outside organization.

The diversity in business partner type and functional area undeniably generates complexity in a semiconductor company's operations. Yet, the selection of business partners is based on an interaction between their characteristics and the company's benefits; selection of a company's preference for one type of partner suggests the existence of more favorable advantages in inter-