THE INDUSTRIAL POLICY DEBATE MINUS PUBLIC RELATIONS: DEPOLITICIZING THE HISTORY OF SEMICONDUCTOR INDUSTRY DEVELOPMENT IN JAPAN

Yoichiro Sato
University of Auckland

Summary

The history of the development of Japan's semiconductor industry has been distorted by public relations by both the Electronics Industry Association of Japan and the Semiconductor Industry Association in the United States, due to the highly politicized trade disputes. This article will examine pre-dispute sources in the original Japanese literature, and consult third-party sources of semiconductor users, in order to reconstruct the distorted history. Through a multi-disciplinary history approach, I find that the Japanese semiconductor industry's strength lay not only in government policies, and in Japan's corporate structure, among other factors.

The semiconductor industry has been at the forefront of American technology in recent decades. Increasing economic challenges by the Japanese and Asian NICs and the loss of domestic industries such as steel, consumer electronics, and automobiles forced the United States to push itself upward on the ladder of structural adjustment. The last resort of structurally devastated industries is to rush to Washington. Congress is flooded by the voices of workers and businessmen from these industries asking for government help.

The US Semiconductor industry has not been exceptionally secure either, especially during the last two decades. Beginning with its petition to the US Trade Representative (USTR) in the late 1970s to restrict the inflow of Japanese chips, its political activities in Washington have been persistent

Debates about the semiconductor industry in Washington and elsewhere tend to be one-sided due to the politicized nature of the issue. The American Semiconductor Industry Association (SIA) propagated its "targeting theory" (that the Japanese government designated the semiconductor industry as a key growth industry and subsidized its growth through various means) in criticizing the Japanese chip industry. The SIA's goals were to protect its domestic chip market, to get the US government to assist the American chipmakers, and to sell its chips to the Japanese market. With strong American faith in liberal non-interventionist economy and free trade, the first two goals were difficult to achieve. The SIA termed

Japanese diversion from the *laissez-faire* economy as "unfair practice," thus providing an excuse for the American chip industry to do the same. Meanwhile, the Japanese side responded by attacking mismanagement of American chip firms and low quality of American labor and chips. Japan's cooperative labor-management relations and unique industrial structure were given credit for promoting quality control in this industry. Both the SIA and the Electronics Industry Association of Japan (EIAJ) amplified these two streams of arguments through systematic public relation efforts since the late-1970s, deeply penetrating journalism, business and economic scholarship.[1]

The purpose of this article is to de-politicize the history of the Japanese semiconductor industry development. What are the over-simplifications, exaggerations, or misconceptions in the American argument? What are those in the Japanese argument? What aspects of the developmental history were purposely omitted? By answering these questions, this article will attempt a more objective, holistic, and multi-disciplinary assessment of the role of industrial policy in the development of the Japanese semiconductor industry.

The Sprouting Stage—Transistor Industry

In 1948, transistor technology was invented at the Bell Research Institute in the United States. Its vacuum tube and transformer engineers first introduced this new technology into Japan. During the occupation of Japan, the General Headquarter (GHQ) of the Allied Occupation required that top Japanese engineers report on their on-going research. The Electrical Testing Center (ETC), Denki Shikenjo, of the Ministry of International Trade and Industry (MITI) Industrial Technology Institute was thus in regular contact with the GHQ. The ETC's head, Sakuji Komagata, was one of those who developed ties with the GHQ. His and others' contacts with GHQ enabled the Japanese engineers to access up-to date

[1] The EIAJ frankly talked about MITI's guidance and the EIAJ's lobbying efforts until both became controversial in the early 1980s. The earlier EIAJ arguments on the positive role of government-business relations were no different from the SIA's arguments in its petitions to the US government. Later publications by EIAJ, in contrast, hardly places any focus on government-business relations. Without access to the earlier Japanese resources, western scholars often receive biased interpretation of the Japanese industrial policies.

information on the invention of transistors. Study groups were formed within the same year, and members made many trips to the GHQ libraries to get the latest journals. (AIDA, 1991a: 105-116, 119-125) As early as 1949, Nippon Telegraph and Telephone (NTT)'s Electrical Communication Laboratory, Nippon Electric Company (NEC), and other makers started basic research for the development of transistors. MITI began subsidizing the research in 1951. NTT Laboratory succeeded in producing proto models of transistors in 1953. In the same year, Tokyo Tsushin Kogyo (later, the SONY Corp.) requested MITI to permit a purchase of transistor technology from Western Electric for $25,000. It was only reluctantly accepted by MITI in 1954. (Nakagawa, 1981: 57-60) MITI's initial reluctance was often cited as evidence of MITI's shortsightedness. (Okimoto, 1989: 65) As Japan's industrial policy later became the target of American criticism in US-Japan trade disputes, the Sony incident became a public relations tool to discredit the mighty MITI theory.[2]

In 1955, Tokyo Tsushin Kogyo applied transistors to its portable radios, and the export of the radios accelerated the production of transistors. By 1958, Japan caught up to the United States in both production volume and technology in the transistor industry. (*Nihon Denshi Kikai Kogyokai* [hereafter, EIAJ], 1979: 159-160) The transistor's application to portable radio was not Tokyo Tsushin'' original idea, however. Texas Instruments had already produced a large profit from the transistor radio boom a year earlier. (Aida, 1991a: 308-311)

MITI's initial reluctance is often interpreted as evidence of a lack of foresight.[3] Nevertheless, articulation of industrial policy was done through close consultation between MITI and the industry, not by an imposition of

[2] For a more balanced account of the SONY incident, see Leonard H. Lynn, "MITI's Successes and Failures in Controlling Japan's Technology Imports," in *Hitotsubashi Journal of Commerce and Management* 29 (1994), pp. 27-30.

[3] MITI officials today often cite the SONY incident, explaining MITI's lack of power. Another often-used example of MITI's lack of foresight is Soichiro Honda of the Honda Motor Co., who rebelled against the MITI's initiative to consolidate the automobile manufacturers into Toyota and Nissan groups. The MITI bureaucrats repeatedly cite these exceptions to the extent that some journalists are now aware of the coordinated public relations ploy. See Marvin J. Wolf, *Nippon no Inbo*, Kenichi Takemura, trans. (Tokyo: Kobunsha, 1984), p. 106.

pre-determined MITI plans.[4] Seeing the Nippon Telephone and Telegraph Laboratory produce a proto model of semiconductor chip in the same year, MITI was quick to respond to SONY's's export success.[5] In fact, MITI seems to have been well aware of the importance of the transistors, but was simply concerned about the shortage of foreign currency reserves. The MITI created an Electronics Division in 1954 upon the initiative of Hiroshi Wada, a government-sponsored student at Massachusetts Institution of Technology (MIT). The division's main objective was proliferating transistor knowledge by promoting basic research, at the time top corporations kept their research totally secret.[6] Hiroshi played a key role in a legislation promoting the Japanese electronics industry. (Aida, 1991a: 206-9)

The 1957 Electronics Industry Promotion Temporary Measure Law (seven-year limited legislation) designated the semiconductor and other electronics-related industries as key industries. (Sugiyama, 1982: 31) The law aimed at:

1) Maintaining and raising [the number of engineers;
2) Providing subsidies and preferential tax treatment for
   a) Infrastructure improvement at universities and research institutes, and
   b) Technological development by the private sector, in order to facilitate the development of indigenous technology;

---

[4] Chalmers Johnson, *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925-1975* (Stanford: Stanford University Press, 1982), p. viii, differentiates the Japanese system from the "fully bureaucratized planned economy" of communist countries that "misallocate resources and stifle initiative."

[5] NTT was a public corporation under the jurisdiction of MITI's archrival, the Ministry of Postal Services.

[6] MITI officials often talk about the *yokonarabi* (horizontal, head-to-head) rivalry among the Japanese firms, which disadvantage them at international deals, and the need for MITI to coordinate them in order to strengthen their collective bargaining. The author heard the same argument in an interview with MITI officials on Japanese electronics industry'' investments in China.

3) Providing long- and short-term loans and preferential treatment for improving, extending, and modernizing the production and testing facilities; promotion of [domestic] joint ventures for the purpose of specialization in production; and
4) Creating domestic demands and promoting exports. (EIAJ, 1979: 56)

Within the ceiling amount negotiated with MOF every year, MITI had a free hand in giving tax breaks to designated industries. (Okimoto, 1989: 88) Upon MITI's request, MOF backed SONY by lifting commodity taxes on transistor radios for the first two years in the market. (*Economisuto Editorial Board*, ed., 1977: 36-8) The effect of the law was significant in closing the gap with the US semiconductor technology that later led to integrated circuits (IC).

Robert Noyce disclosed the behind-the-scenes deal of the MITI's exception. Instead of simply selling the Kirby patent (a patent for basic IC structure invented by Jack Kirby) through licensing, MITI in 1967 threatened to file lawsuits against all Japanese producers, which violated the patent. The building of manufacturing sites in Japan was a concession MITI won through tough negotiations. (Kano, 1980: 110-1) The Kirby patent was sold, in the late 1960s, to the Japanese companies for a 3.5% royalty. (Kano, 1980: 100)

After September 1967, MITI's control over foreign capital was gradually relaxed in the face of foreign criticism. In 1967, foreign investment was liberalized in 50 industries (50% or 100% ownership depending on the industry). The number of the liberalized industries increased to 204 in 1969 and 524 in 1970. Nevertheless, according to the EIAJ, only industries that were not vulnerable to foreign investments were chosen until the 1970 liberalization. (EIAJ, 1979: 98-9)

Protection of the domestic semiconductor and computer industries by the Japanese government was problematic for the Nixon administration. Early in the summer of 1971, William Eberle, Special Trade Representative (STR) of the United States, and Pete Peterson, Commerce Secretary, were facing demands from domestic corporations, such as Motorola and Texas Instruments (TI), that the US government push Japan for trade and investment liberalizations. Eberle, in May, went to Tokyo with a threat of filing a GATT suit. (Dryden, 1995: 162) On August 15, 1971, Nixon also announced a 10% surcharge on imports, creating bargaining leverage for the

United States in the exchange rate negotiation. According to a Commerce official, lifting of the 10% surcharge was also linked with Japan's trade and investment liberalization in the semiconductor and computer industries. (Dryden, 1995: 151, 158) However, the policy split within the US administration was clear.

The liberation did not alter MITI's techno-nationalism. The legal relaxation left MITI with its favorite tool: administrative guidance. TI's Michael Rice also admits that MITI, through administrative guidance, limited the number of wafers TI could send from the United States to its factories in Japan until 1976. (Kano, 1980: 108) A similar story can be heard from another company as well. Jones (first name unknown), sales manager and vice president of Advanced Micro Devices (AMD), discloses his struggle with MITI:

> "In 1974, when AMD established its local subsidiary in Japan, we tried to insert 'production of Ics' in the company's charter. Nevertheless, because of this [phrase], MITI's permission was not easily granted, and we had to delete the phrase." (Kano, 1980: 111-2)

Computer Industry

The Japanese semiconductor industry benefited from the promotion of the domestic computer industry because the technology was closely connected to it, and because major semiconductor manufacturers were also general electronics makers involved in computer manufacturing. MITI's promotion of the domestic computer industry was a direct response to IBM's predominance in the Japanese and world computer markets. In 1955 and 1956, subsidies were provided for, "disassembling and analyzing the parts of foreign-made computers." (EIAJ, 1979: 223) The 1957 Electronics Industry Promotion Temporary Measure Law assisted the computer industry as well. In 1960, the Japanese government forced IBM Japan to disclose their basic patent of computers in return for a permit to start production of computers in Japan. (EIAJ, 1979: 223) The other leverage of MITI over IBM was the Foreign Currency Control Law.[7] Because of the

[7] MITI often selectively intervened in technology transfers, and issued guidance to lower royalties. Nevertheless, in the case of the NEC-Fairchild deal, MITI failed to quiet infighting of domestic companies. Hitachi and Toshiba were reluctant to profit NEC by purchasing the planar patent. The

law, IBM Japan needed MITI's permission to transfer its profits to the United States. MITI also used this leverage to make IBM disclose its patent. (Kojima and Ikebata, 1984: 20-1)

In August 1961, major domestic computer manufacturers under the 1957 Electronics Industry Promotion Temporary Measure Law formed Japan Electronic Computer Co., Ltd. (JECC). JECC engaged in a computer rental business to promote sales of domestic computers. Its starting fund was 1.05 billion yen ($2.9 million), and the Japan Development Bank (JDB) loaned 400 million yen ($1.1 million). 1.1 billion yen ($3.1 million) were spent for the purchase of domestic computers. By 1971, its capital expanded to 53.4 billion yen ($173.4 million), the accumulated sum of JDB loans reached 109.7 billion yen ($356.2 million), and computer purchases for the year hit 87.4 billion yen ($283.8 million). (EIAJ, 1979: 77-8) MITI first suggested in 1960 that JECC be financed half by the government and the rest by the private sector. The plan was changed to a completely private sector-based one in the next year. (EIAJ, 1979: 224)

In 1962, under the Promotion Measure Law, research to produce a prototype model of a large high-performance computer began. The research resulted in co-development of FONTAC computers by Fujitsu, Oki and NEC. (EIAJ, 1979: 224) Between 1966 and 1978, 45 billion yen ($150 million) of Computer Research and Development funds was provided by the Japanese government under the Large-scale Industry Technological Research and Development Contract System. (EIAJ, 1979: 271) NEC reports, "as a research outcome from the MITI's Large-scale Project, [NEC] developed 144 byte high-speed N-channel MOS IC memories in March 1968." (*Nihon Denki Kabushiki Kaisha Shashi Hensanshitsu*, 1980: 103)

Japanese firms started automation of their production line with the help of MITI. In 1969, NEC received MITI's subsidy to study automation of the semiconductor wafer process. (*Nihon Denki Kabushiki Kaisha Shashi Hensanshitsu*, 1980: 160) Furthermore, as the anticipated deadline of market and capital liberalization in the computer and IC industries neared in the mid-1970s, the Japanese electronics industry asked the Japanese government for financial assistance for technological development. (EIAJ, 1979: 288-9) For the fiscal years 1972 and 1973, 3.5 billion yen of IC

---

two companies decided to develop their own manufacturing technology that would bypass the planar patent. Their inventions resulted in lowering of electrical noises, which worked in their advantage in commercial application of silicon transistors.

Development Subsidy was paid within the 20 billion yen ($66.7 million) Computer and Other Development Promotional Subsidy. In addition, some 1 billion yen was paid for the development of IC manufacturing equipment under Important Technology Research and Development Subsidy and other programs since 1968. (EIAJ, 1979: 271)

In 1971, major Japanese computer firms formed three companies: Fujitsu-Hitachi, NEC-Toshiba and Mitsubishi-Oki. Under the Specific Electronics and Machinery Industries Promotion Temporary Measure Law (which combined the 1957 Electronics Promotion Law and the Machinery Industry Promotion Law), MITI provided a 68.7 billion yen ($229 million) subsidy between 1972 and 1976 to these three companies. The three companies announced their new models in 1974. (EIAJ, 1979: 226-8)

The Contribution of the JECC (rental firm) was recognized by EIAJ in its own publication. “Since 1961 when JECC’s rental operation began, purchase of domestic computers [in Japan] exceeded that of foreign machines.” (EIAJ, 1979: 224) The SIA cited the JECC as yet another example of unfair economic practices. In contrast to its own earlier comments, the EIAJ responded by saying, “there is a citation of the area unrelated to semiconductors: regarding the JDB loans to JECC. (EIAJ *Denshi Debaisu-shitsu*, 1983: 27) The fact that all new models of Japanese computers after 1968 were equipped with Ics (EIAJ, 1979: 224-5) hardly denies the relationship between LECC and IC development. In fact, the entire amount of the Computer Development Promotion Subsidy in 1977 was spent for Very Large Scale Integration (VLSI) research and development (R&D). (EIAJ, 1979: 159)

Semiconductor Industry in the Advanced Stage

By the late-1970s, the semiconductor industry had become increasingly capital-intensive. Therefore, the development of new chips became very costly. Investment in infrastructure increased from 12.5% of sales in 1978 to 18.4% in 1980 in the case of the Japanese semiconductor industry, while the American industry increased from 12% in 1973 to 16% in 1980. Investment in R&D is estimated to reach five to ten percent of sales. Considering the fact that the volume of sales also increased, this increase in R&D is significant. Thus, “competition in accessibility to capital and technological development determine the future of the American and Japanese semiconductor industries.” (Itami, 1981: 39-45)

The life cycle of semiconductor chips was extremely short, while the cost for development had increased. The integrity of mass-produced chips

increased from 256 bytes in 1970 to 1 kilobytes in 1973, 4 kilobytes in 1975, 16 kilobytes in 1977, and 64 kilobytes in 1979. (Shimura, 1980: 272-294) Older generation products have been pushed out of the market. Thus, producers had to advance to the next stage as soon as possible.

In addition, the learning-curve theory can be applied to the semiconductor industry. In the semiconductor industry, the production cost declined by 27.6% when the production doubled. (Shimura, 1980: 290) Therefore, the more a company produced, the lower each chip cost to produce. This production cost related to the ratio of yield (non-defect chips). The ratio was calculated by multiplying the ratio of non-defect chips per wafer and the ratio of non-defect wafers. (Hizuka, 1988: 90-113) By improving purity of the silicon wafers, cleanliness of the production environment to prevent dust and increasing the accuracy in the circuiting process, the yield ratio could be increased and cost reduced.

These characteristics created a strong incentive for higher market share. Early domination of the market reduced production costs, while preparing the company for cutthroat price competition against the late entries during the latter stage of the product cycle. Capital abundance created from this early domination could also be used for development of new chips to enable early entry into the next product cycle. Thus, in the semiconductor industry, a loss in one stage would put a company in a highly disadvantaged position. Increasing R&D costs made most non-captive chip makers in Silicon Valley unable to compete vis-à-vis captive makers and general electronics firms (both Japanese and American) on a VLSI was already risky enough to take individually. It was in such a context that the Japanese government launched its VLSI research association.

VLSI Research

In the wake of the liberalization, the Japanese electronics industry needed a final technological push to compete evenly with American producers. The 1971 law that combined the promotion of the machinery and electronics industries under one legislation clearly aimed at close coordination between the electronics industry and the manufacturing tool industry. (Kodama, 1991: 123-5) At the up-stream of the semiconductor industry, the computer industry was always tied with the semiconductor industry. From 1972 until 1976, a “Computer Development Promotion Subsidy” was provided. In 1973 and 1974, an “IC Development Promotion Subsidy” was also provided. Mitsubishi’s corporate history book writes, “This Company, through participation in both projects, achieved a big

technological advance including production of proto models of 16 kilobyte (16K) dynamic random accessible memory (DRAM) chips. (*Mitsubishi Denki Kabushiki Kaisha Shashi Hensanshitsu*, 1982: 601) A test by Hewlett-Packard (H-P) revealed that Japanese 16K DRAMs achieved better quality than American-made 16Ks. (*House Subcommittee on Trade*, 1980: 36-41)

With the production of 16Ks, the automated lead bonding process became the norm, and Japanese producers had an advantage in this area. NEC, first in the world, developed a micro computer-controlled automatic bonder in 1973. In the next year, NEC introduced a pattern recognition system; thus, completely eliminating workers in the bonding process. NEC also improved its computer-controlled IC testers. (*Nihon Denki Kabushiki Kaisha Shashi Hensanshitsu*, 1980: 159-161) Franklin B. Weinstein, Michiyuki Uenohara and John G. Linvill (1984: 65) note:

> Although some US companies pioneered the automation of the semiconductor industry, there seems little doubt that the Japanese made more extensive use of automatic lead bonding machines and have been doing so for a longer period of time.

The delay in automation by the US manufacturers could partly be attributed to their initial decision to take advantage of cheaper labor costs at offshore (Southeast Asian) assembly facilities. (Weinstein, Uenohara and Linvill, 1984: 63) Nevertheless, it is also true that the Japanese government encouraged investment by domestic firms in updating production facilities through subsidies and tax incentives. Until 1983, MITI provided a 13% tax credit on the purchase of, "robots, numerically controlled (NC) machine tools and other automated assembly-line equipment." (Okimoto, 1984: 101)

In March 1976, MITI coordinated a four-year co-research project to, "study and develop basic and manufacturing technology in order to realize VLSI for the next generation computers." (EIAJ, 1979: 156) The VLSI Technology Research Association was formed by five major electronics firms: Fujitsu, Hitachi, Mitsubishi, NEC, and Toshiba, and cooperated with NTT and MITI's Electronics Technology General Research Institute. MITI was to shoulder 30 billion yen ($107.1 million) out of the total research fund of 72 billion yen ($257.1 million). (EIAJ, 1979: 156) MITI actually paid about 29.1 billion yen ($103.9 million). (Denshi, 1983: 10) This subsidy came as a direct response to IBM's new model computer, "Future System," expected to be released in 1980. Shoei Kataoka, Electronics

Section Chief at the Electronics Technology General Research Institute recalls:

> "This co-research project originated in the urgent need to establish micro manufacturing technology, in response to the speculation that IBM's "Future System" computers used micro-structured semiconductor devices." (*Tsusan Journal*, 1982: 24)

In response to the SIA's charge of unfair trade, EIAJ says, "the VLSI project subjected very basic fields including micro manufacturing technology of semiconductors, but it did not subject development and commercialization of 64K DRAMs." (*Denshi*, 1983: 10) Weinstein, Uenohara and Linvill (1984: 19), cite a 1981 *Electronics* article to show the reluctance of the participating firms to send their best engineers to the project.[8] Nevertheless, a directly conflicting view came from within the Japanese chip industry. NEC's Atsuyoshi Ouchi recalls:

> "The theme, as well as the timing, [of the project] was good. If the VLSI [project] focused only on the extension of the optical technology which each maker had, advanced companies would try to hide the newest technology, and the lagging companies would only try to take, thus [the project] would not go well. But, in good timing, it became known that the VLSIs for IBM's "Future System" computers did not need the extension of optical technology, but rather electron beams and X-ray technologies. If so, there was a sense of crisis that even Japan's relatively large makers could not individually develop such devices, and there was no room for suspecting each other since the starting point was zero for everybody. I heard one young engineer, who participated in the co-research, say, 'I was sent without instruction. I thought I would damage the company's image if my work were inferior. So, I tried hard.' It seems that everybody did the best in such a mood. I think this is one of the reasons of success." (*Tsusan Journal*, 1982: 24-5)

---

[8] Another article, John P. Posa, "Special Report: How Japan's Chip Makers Line Up to Compete," in *Electronics* (6/2/81), pp. 113-132.

The operation committee of the project consisted of vice-presidents of the participating firms sent to smooth the decision-making. Each firm sent its best human resources to the joint research laboratory. (Moritani, 1981: 158) The result of the project was striking. The VLSI project's Co-research Institute Chief Yasuo Usui commented, "Compared to IBM, I think, the Co-research Institute's technology broke the even level. Especially, I think, [the institute] surpassed IBM in electron beam lithography devices." (Moritani, 1981: 145)

In April 1977, NTT's Musashino Electric Communication Laboratory was first in the world to announce development of 64K DRAMs. In May, the VLSI project team succeeded in an experiment of electron beam lithography for VLSI production. In November, NTT succeeded in production of 1K MOS memories and masks for 64Ks, using the newly developed electron beam lithography. (*Nippon Denki Kabushiki Kaishi Hensanshitsu*, 1980: 103, 105) The major participants of the project, NEC, Hitachi, and Fujitsu developed 64K DRAMs in 1978 and 1979. (Ouchi, 1979: 863-9; cited in Kato, 1988: 4) The project applied for more than 1,000 manufacturing patents in electron beam lithography, micro manufacturing, silicon crystallization, wafer-processing, designing, testing and device technologies. (Kato, 1988: 3) The significance of the research results can be measured by IBM's request that Japan disclose these patents, and by MITI's reluctant disclosure in March 1978. (EIAJ, 1979: 156-7) Thus, EIAJ's recent claim that the VLSI research had nothing to do with 64K DRAM production is not true. The research played a major role in both basic and manufacturing technologies. Its focus on basic manufacturing technology enhanced close coordination of the electronics industry, between computers, semiconductors, and semiconductor manufacturing equipment industries. It was around this time that some Japanese semiconductor manufacturing equipment exceeded the capacity of the American-made ones. (Kato, 1988: 12; Moritani, 1981: 153-7)

Public relations penetrate academia. Prominent Japanese speakers on electronics have industrial ties, which are usually not disclosed very well. One of the authors of the above-cited Okimoto book, Michiyuki Uenohara, was an associate senior vice-president of NEC. (*Electronics*, 1981: 60) Furthermore, Michiyuki is an editor of *Look Japan*, a journal distributed overseas under the Ministry of Foreign Affairs budget. Hiroshi Inose, a Tokyo University researcher, was a director of the School of the National Computer Center and, like Michiyuki, is a *Look Japan* editor. (*Electronics*, 1981: 60; *Look Japan*, 1994: 2)

Financial Advantages

SIA's charge against the Japanese semiconductor industry included the government role in loan allocation. It charged that the JDB loans funneled necessary funds and stimulated commercial loans to the semiconductor industry. EIAJ counter-argued that the JDB loans were small, and that it did not have any influence over the commercial bank's loan making decisions. (*Denshi*, 1983: 13)

Japanese corporations relied heavily on commercial bank loans. According to a former MITI official, "Commercial banks rely on MITI's judgment in making their loan decisions." (Ojimi, 1972: 126) Shoichi Akazawa, who retired from MITI and became vice-president of Fujitsu, commented that [while he was at MITI] he never asked commercial banks to lend money [to the particular private companies]. (Shimura, 1980: 280) However, such a comment needs critical examination. Shoichi heads the MITI-affiliated Japan Economic Foundation, which publishes a public relations journal, *Journal of Japanese Trade and Industry*. (*Zenkoku Kakushu Dantai Nenkan*, 1991: 27)

In addition, Japanese law allowed commercial banks to send managers to the loan recipient firms in case of bad credit. Therese M. Flaherty and Hiroyuki Itami (1984: 155-6) argue that, in the case of the semiconductor industry, such a close relation between commercial banks and manufacturers made possible sophisticated analysis of the industry's prosperity. MITI's designation of the industry as a developing target, therefore, enhanced consensus building between the industry and banks.

Authorization of expenditures, or approval of credits by Japan's public banks such as the JDB, was done by MITI. (Johnson, 1982: 79) However, EIAJ argues the amounts of JDB loans were small, and the interest rate difference was minor (based on data from 1982). (Denshi, 1983: 13) Until the early to mid-1970s, most JDB loans were poured into basic infrastructure industries, such as electrical power generation and transport, and the interest rate difference was over 3%. However, Japan's excess savings over business demands curtailed the role of government banks. Though the computer, electronics and machinery industries combined, received over $300 million from JDB in 1981, the rate differential was only one percent and the signaling role of such loans was less important. (Okimoto, 1984: 130-1) Unfortunately, for those other than managers of the semiconductor manufacturers, the significance of the one percent interest rate difference is largely dependent on subjective interpretation.

However, in my interview, EIAJ's Harada suggested that less visible tax breaks were more important than more visible direct subsidies in the development of the Japanese chip industry.[9]

NTT's procurement, MITI's subsidy, cartelization, and JDB's loans played important roles at critical times during the infant stage of the Japanese semiconductor industry up to the early 1970s. Nevertheless, since the late-1970s, difference in corporate structures between the American and Japanese semiconductor firms, which affected their ability to raise ever-increasing investment capital for production of higher integration chips seems to have accounted for the industry's growth.

During the 1970s, Hitachi, Toshiba and Mitsubishi were already big general electronics makers. To a lesser extent, NEC, Fujitsu and Oki also had diversified, but still integrated, product lines. As R&D costs and investment in infrastructure skyrocketed, they gained financial advantage over the non-captive chipmakers of Silicon Valley. (Itami, 1981: 39-40) While R&D and infrastructure investments by American firms stagnated in 1974 and 1975 in the wake of the 1973 oil crisis, Japanese firms kept spending 20% of their sales for R&D for the same period. In the late 1970s, they started large investment in 64K production facilities, though this did not seem to result in immediate profits. (Moritani, 1981: 149-150) Concerning the nature of massive simultaneous investments by Japanese firms, AEA's John P. Stern suspects MITI's role in this decision. He pointed out that MITI's Industrial Structure Council, which dealt with investment strategy, refused participation of foreign firms for several years. (Stern, 1985: 15) However, it seems more plausible that the excessive investment drive simply reflected the extremely short product cycle of the memory chips and the resulting urge for early market domination, which allowed firms to collect "back rent." The financial advantage of the diversified Japanese companies that have technologically caught up with the US rivals by the early-1980s, made it possible fully to take advantage of the learning curb and drive out the competitors through price-cutting.

Conclusion

Despite the politicized nature of the US-Japan semiconductor disputes and the distortion of media information and academia on this subject, earlier publications by EIAJ and other Japanese sources clearly show MITI's orchestrating role in the development of Japan's semiconductor industry.

[9] Interview with author, Tokyo, 27 April 1995.

The more visible legal protection, such as tariffs, quotas, or import bans, was lifted by the early-1970s. Nevertheless, less visible measures, such as control of foreign direct investments, encouragement of technology transfer, government-directed research, NTT's closed procurement system, and cartelization were practiced under MITI and MPT's administrative guidance.

Though the amount of direct subsidy was relatively small, the importance of such subsidies, particularly during the infant stage of the industry, as well as indirect effects of such subsidies, and other means of protection and promotion including tax exemption, cannot be overlooked. Some advantage of Japanese firms could be attributed to Japan's closely coordinated industrial structure and bank-centered *keiretsu* system, but it is also important to note that these structural characters may very well disadvantage the Japanese firms, as we see in the 1990s.

Most previous explanations of the growth of the Japanese semiconductor industry were mono-disciplinary and paradox-free. This multi-disciplinary study of the history of the development of the Japanese semiconductor industry reveals richness in paradoxes. Protection of the domestic market from competitions with foreign firms was done through quotas and tariffs. However, the domestic industry was also made aware of the coming end of such protection. Promotion of the domestic firms clearly aimed at upgrading their technological competence within a given time before the trade and investment liberalization. MITI encouraged cooperation among the domestic firms, but at the same time, maintained competition between plural groups of firms. Also, MITI's disciplining of domestic firms was often imperfect, and major breakthroughs often originated in the "black sheep" companies SONY and NEC's early switch from germanium to silicon, NEC's purchase of the planar patent, and the growth of the silicon material industry in Japan attest to this view. While research cartel was used to avoid redundancy among domestic firms, jurisdictional competition between MITI and MPT created a built-in redundancy in Japan's industrial policy for electronics. NEC and Sharp's early calculator success owed more to MPT than MITI. Also, support of MPT allowed NEC and other "NTT-family" firms a degree of freedom from MITI.

The paradoxical mixture of policies worked and failed from time to time, and this one case study does not allow me, nor do I intend, to draw a generalization theory of industrial growth as such. Throughout the semiconductor industry's development stage, MITI listened to the industry

and tried to build consensus among domestic firms. Once consensus was achieved, MITI enforced it strong-handedly. Occasional resistance of some domestic firms could not be avoided. When complaints amounted to a level where enforcement of the original consensus was threatened, MITI responded to the complaints quickly. Such examples are seen in the tax break for SONY's transistor radio export and subsidization of NEC despite NEC's repeated disobedience to MITI. Thus, constantly learning from its own failure seems to have been MITI's real strength. Although MITI's industrial policy did play a role in the development of the Japanese semiconductor industry, findings of my study suggest that MITI's record of success is not as rosy as the SIA would like to portray. Neither the EIAJ's recent version of "incompetent MITI" explains the success of the Japanese semiconductor industry.

WORKS CITED

Abegglen, James C. 1970. *Business Strategies for Japan*. Tokyo: Sophia University and TBS Britanica.

Aida, Yutaka. 1991a. *Denshi rikkoku nihon no jijoden (jo)*. Tokyo: NHK Books.

____. 1991b. *Denshi rikkoku nihon no jijoden (chu)*. Tokyo: NHK Books.

____. 1991c. *Denshi rikkoku nihon no jijoden (ge)*. Tokyo: NHK Books.

Dryden, Steven. 1995. *Trade Warriors: USTR and the American Crusade for Free Trade*. Oxford: Oxford University Press.

Electronics. 1981. 21 April.

"Electronics Industry Association of Japan" [EIAJ]. 1995a. *Semiconductor Fact* 1995. No. 4.

____. 1995b. *Semiconductor Fact* 1995. No. 5.

Flaherty, M. Therese and Hiroyuki Itami. 1984. "Finance." In Daniel I. Okimoto, et al., eds. *Competitive Edge: The Semiconductor Industry in the US and Japan*. Stanford: Stanford University Press. Ch. 5: 134-176.

Hizuka, Hiroshi. 1988. "*Handotai Sangyo no Kasen Taisei (Jo)—Kyosoteki Kasen Taisei Bunseki*." In *Ritsumeikan Keizaigaku*. April: 90-113.

Itami, Hiroyuki. 1981. "*Setsubi Toushi ga Kyosoryoku no Shihyo ni—Handotai Kigyo no Taishitsu wo Sayu suru Kinyu System*." In *Nihon Keizai Kenkyu Center Kaiho*. 1 November: 39-45.

Iwai, Masakazu. 1984. *Toshiba no sentaku*. Tokyo: Daiyamondo-sha.

Johnson, Chalmers. 1982. *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925-1975*. Stanford: Stanford University Press.

Kano, Akihiro. 1980. "*IC—mikuro no tatakai*." In *Bungeishunju*. September: 94-116.

Kato, Yoshiro. 1988. "*Nihon no handotai sangyo ni okeru gijutsu kyoso to boueki masatsu*." In *Keizai Keiei Ronshu* 27 (4). March: 1-21.

Kodama, Fumio. 1991. *Analyzing Japanese High Technologies: The Techno Paradigm Shift*. New York: Printer Publishers.

Linvill, John G. and Franklin B. Weinstein. 1984. "Background." In Okimoto, et al., eds. *Competitive Edge: The Semiconductor Industry in the US and Japan*. Stanford: Stanford University Press. Ch. 2: 9-34.

Look Japan. 1994. October.

Lynn, Leonard H. 1994. "MITI's successes and failures in controlling Japan's technology imports." In *Hitotsubashi Journal of Commerce and Management* 29: 15-33.

"*Mitsubishi Denki Kabushiki Kaisha Shashi Hensanshitsu*" [Mitsubishi Electric Company Corporate History Editorial Board]. 1982. In *Mitsubishi denki shashi soritsu 60 shunen*. Tokyo: Mitsubishi Denki Kabushiki Kaisha Shashi Hensanshitsu.

Moritani, Masanori. 1981. *Nichi-bei-ou gijutsu kaihatsu senso*. Tokyo: Toyo keizai shinposha.

"*Nihon Denshi Kikai Kogyokai*" [Electronics Industries Association of Japan, referred as EIAJ in text]. 1979. In *Denshi kogyo 30 nen shi.* Tokyo: Nihon Denshi kikai Kogyokai.

Nihon Denshi Kikai Kogyokai Denshi Debaisu-shitsu [EIAJ Electronics Device Division]. 1983. "*SIA ni yoru nihon no tagetto seisaku hihan ni taisuru hanron*." In *Denshi*. April: 25-30.

Nihon Denki Kabushiki Kaisha Shashi Hensanshitsu [Nippon Electronics Corporation Corporate History Editorial Board]. 1980. *Nippon denki saikin junen shi*. Tokyo: Nihon Denki.

Ojimi, Y. 1972. "Basic Philosophy and Objectives of Japanese Industrial Policy." In *The Industrial Policy of Japan*. Paris: Organization of Economic Cooperation and Development. 11-31.

Okimoto, Daniel I. 1989. *Between MITI and the Market: Japanese Industrial Policy for High Technology*. Stanford: Stanford University Press.

Okimoto, Daniel I. 1984. "Political Context." In Okimoto, et al., eds. *Competitive Edge: The Semiconductor Industry in the US and Japan*. Stanford University Press. Ch. 4: 78-133.

Okimoto, Daniel I., Takuo Sugano and Franklin B. Weinstein, eds. 1984. *Competitive Edge: The Semiconductor Industry in the US and Japan*. Stanford: Stanford University Press.

Omae, Masaomi. 1979. "*Nichibei keizai senso: naze denden kosha wa neraware ta ka."* In *Chuokoron*. July: 251-265.

Ouchi, Atsuyoshi. 1979. "*IC wo meguru saikin no wadai*." In *Denshi Tsushin Gakkaishi* 62 (8). August: 863-9.

Posa, John P. 1981. "Special Report: How Japan's Chip Makers Line Up to Compete." In *Electronics*. 2 June: 113-132.

Seiji Keizai Kenkyujo, ed. 1955. *Nihon ni okeru gaikoku shihon*. Tokyo: Toyo Keizai Shinpo-sha.

"*Sekai ni kisou nihon no IC sangyo*." 1982. In *Tsusan Journal*. February: 16-28.

Shimura, Yukio. 1980. "*Tokubetsu Hokoku Nichibei Handotai Senso*." In *Chuokoron*. June: 272-295.

Stern, John P. 1985. "*Nichi bei boueki masatsu no yukue*." In *Jiyu*. November 1985: 10-7.

Sugiyama, Shuji. 1982. "*Waga kuni handotai sangyo no genjo to kadai*." In *Tsusan Journal*. February: 29-33.

Takai, Toshio. 1981a. "*Hito ha Nichibei Handotai Trouble to Iuga*." In *Jiyu*. September: 47-64.

____. 1981b. "Technologists See Japanese Closing Gap." 1981. In *Electronics*. 21 April: 48, 50, 60, and 62.

US Congress, House Committee on Ways and Means, Subcommittee on Trade. 1980. *Market Conditions and International Trade in Semiconductors: Field Hearing before the Subcommittee on Trade of the Committee on Ways and Means*. 96th Cong., 2nd session, 28 April.

Weinstein, Franklin B., Michiyuki Uenohara and John G. Linvill. 1984. "Technological Resources." In Okimoto, et al., eds. *Competitive Edge: The Semiconductor Industry in the US and Japan*. Stanford: Stanford University Press. Ch. 3: 35-77.

Wolf, Marvin J. 1984. *Nippon no Inbo*. Translated by Kenichi Takemura. Tokyo: Kobunsha.

Zenkoku Kakushu Dantai Nenkan. 1991. Vol. 2.