

# Reconsideration: Competition, Rivalry and Firm System

—A Case of Semiconductor Industry—

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## introduction

Japanese firms in the semiconductor industry are running very rapidly. This is rather terrible facet to hitechnology buisness in US economy, I guess. The sales share of Japanese firms in US proper come to about 90% and more in specific devices branches. Who could predict this fantastic situation ? Only a few economists know that the important competitive factors are cost-dominance, performance-dominance and demand-dominance. But most of economists have not been able to illustrate these factors in well-defined way.

It is likely that in economics the meaning of competition is clear-cut. Because it is an determinant element whether product's price come close to its marginal cost in such a competitive case. But in practice we are not able to attribute to only "price = marginal cost" approach. Usually economist takes perfect competition as an base of economic model framework, but in real world the basic market structure framework is one kind of oligopoly with some degree of concentration and price determina-

tion formula is due to the so-called mark-up principle. A substance of familiar competition consists in competitive power that is equal to the meaning of rivalry, but not to that of economic competition. Saying paradoxically, "too little competition" equals to "too large rivalry".

In this paper I'd like to research some practical differences between competition and rivalry. Besides I will do it in comparison with US and Japan in the two semiconductor industries.

## § 1 present industry in cultural complexity

Semiconductor industries are rightly in the war. It seems that the war is endless. What is it all about ? Many researchers say that visible result of the long war appears to be self-evident. What happened ? Could we explain the result in terms of rivalry or competitive power ? The problem is very difficult even for intelligent economists and management scientists to answer. Why ?

The keyword to the answer is rightly in "technology", I believe. Technology has an dense relation with three vital economic and managemental points. As I refered above these are three dominance factors of cost, performance and demand. We can see the difference of technology structure in two countries, US and Japan. In microscopic sense, technology is rational and strong base to give competitive power to entrepreneurs. Strictly speaking technology does not depend on interaction of demand-supply in market, and it has also no relation with so-called economic competition. In economic competition any firm can't yet survive by using their weapons named "new technology". As by invisible Goddess' Hand every economic merit disappears to zero sooner or later,

any entrepreneur has fatally not strong incentive to create new technology. Although he can always decrease production cost by means of cheap labor cost and transaction cost, they can't always use technological device driven by necessity. We can research mainly technological type contributing to cost-dominance and performance-dominance. Generally speaking technological advantage leads necessarily to cost-dominance and performance-dominance. Technology itself doesn't cut cost dominance, but entrepreneurs' efforts to apply their technology to their own basic research, product development and production process always decrease the cost definitely. That is because for instance R&D investment is very important feasible strategy. Japanese firms are good at implementing product development and production process innovations, but not creating basic research. This is Japanese technological character, I guess. Which of them is the most critical ?

An pre-history of this industry tells us the truth in part. For instance, a market share of Japanese industry in this world is considerably changeable on each past ten-years-period, especially in 1970's and 1980's. I'm afraid most of economists use the term, competition, without knowing well the real world situation of rivalry. Because rivalry is'nt mere economic phenomena, it is surely socio-economic and even political one. To put it shortly, rivalry has close relation with the phenomena of cultural complexity. A certain scientist at the production spot tells us the following, that is, if Japanese has a definite target and do it, their creativeness must be revealed at the best<sup>(1)</sup>. Europeans and Americans hate losing their market inter-dependence and dislike to behave according to the others' ideas. They say that every Japanese has the same kind of opinion, so he doesn't worry about such a troublesome thing. The basic

structure of Japanese society looks as if a lot of pebbles are bound by a very strong rope into one, and they are standing side by side. But reversely in the European society every one looks like a massive and heavy stone bound loosely by a thin rope each other. Even though one of them is to move, the others don't move and are standing still with no influence. This is true democracy, I think. However things are different in Japan. As soon as one stone moves, every stone starts to move all together. This is the meaning of consensus in Japanese customs. In other words this is way of Japanese-typed cooperation.

Prof. Morishima, in his book<sup>(2)</sup>, tells us that he had wanted to search the same Japanese version (as Asiant giant) as M. Weber had analysed regarding social relations between capitalism and rational spirits in 19th century's European society. Of course his work is merely one tried essay, but this idea is very much unique and interesting for researcher of Japanese enterprises. But no matter how eagerly he endeavoured to search the status of Confucianism in Japanese history, I'm afraid his discussion has a lot of persuasion for me to say the least. In discussing that the spiritual climate underlying Japanese success in industrial economy, I wonder how  $\overline{K\bar{O}}$  and  $\overline{CH\bar{U}}$  as Confucian spiritual factors are useful for attacking the theme called "Why Japan succeeded in economic performance?". I believe, though we must know there is any relation between concerned ethical factors and Japanese-typed success, we have not been able to give a persuasive interpretation to respectful and eager researchers yet.

## § 2 backgrounds of competitive oligopoly

Though competitive oligopoly is a type of economic homogeneous oligopoly, its concept includes many parts which can't be explained by help of orthodox economic theory. Besides the business proper is one whose match is ruled by price-cutting and R&D action. In modern times the related enterprises are compelled to implement their own strategies in the global and border-full business strategy world, in order to increase their own market share of sales<sup>(3)</sup>.

The minority of economists believe that the essence of oligopoly consists in non-price competition. By the by it seems that above price-cutting is a factor of price competition. In fact that is not wrong. But strictly speaking the core of a problem doesn't insist in price-cutting but cost-cutting (namely, cost-economising). So we had better consider an interrelation between economising cost and R&D action. Which is the first to do among the two ? Many people must think that suitable success of R&D action comes to realizing cost-economising. Is that true ? Saying paradoxically, I dare to say cost-relevant success plays an important role as a powerful guide to R&D action, for example, R&D investment. We need to notice that specially in the semiconductor industry we cannot tell rightly the difference between price-cutting induced by cost-economising and by mismatch of demand-supply relations. Indeed in the case of the latter the price is apt to fall more rapidly than in that of the former. Of course the former is in our main interest. In the concerned industry percentage of non-bad articles (so-called BUDOMARI in Japanese) has a large influence upon cost-cutting. Expanding on that situations, it is very important how many pieces

of chips engineers can get from a piece of wafer. And the most of technological analysts say the larger piece (in area) of chip they can get, the worse BUDOMARI they have on a piece of chip. How many pieces of chips they can cut off is dependent on the ultra-high technology in this industry. Moderate cost-cutting enables them to sell at lower price, by which enterprises may add to their own shares of sales, exclusive of dumping case. This fact induces them to implement larger investment for R&D and for plant surely and swiftly. In that case "hesitating" is not forgiven for their own survival, because they have ever learned a vital lesson from the proverb "Strike while the iron is hot". Specially Japanese enterprises have implemented an enormous amount of investment even in the midst of depression. This is a rule patterned by Japanese enterprises.

Most of modern economists used to tell us that in the period of Japanese high-growth there were a representative competitive oligopoly in the automobiles and home-electronics industries which the growth of demand is rather high. The characteristic in point was that we could see declining price in the long-run with the rise of productivity. This type of oligopoly which I dare to call oligopoly in rivalry here, is apt to have considerably high seller's degree of concentration, but to change frequently the order of rate of share in the market. As each producer has continued to win large merits coming from economy of scale and technological innovation, he faces to a kind of complex rivalry in respect of capital formation for plant and R&D and even price formation. Speaking from specific cycle in semiconductor industry and the like, the price declines periodically and often radically but not in the long run. Of course as if the price declines sharply, it can not be under the competitive lowest level. There must be reason for it. This is a kind of high technological

barrier for entry coming from product differentiation proper. Therefore a change in the rate of share is rather small and the concerned makers are able to keep up a large rate of profit on the average.

The basement of economic action is no doubt market economy. Market economy means a mode of economic transaction using market mechanism and market process mainly and effectively. We have two problems here. One is whether a certain country in trade can offer any open opportunity for market transaction to his partners or not. This triggers a clear friction of incomes between the both countries. The other is how government can discriminate between system of transaction through market (i. e. market system) and so-called firm system in carrying out the feasible industrial policies. In this article we can not afford to go into details of Japanese industrial policies in particular, but I'm afraid that the present situations of representative specific industries in Japan (for instance, automobile, semiconductor in present and HDTV in future) characterizes Japanese industrial policies themselves on the other hand.

While Japan has developed the strength by means of protectionism in the help of her government, US has done so by means of free trade in the help of free enterprise. Now Japan is going to adopt the free trade policy and US is going to adopt the protectionist policy. Ironically Japan resulted in having more stronger competitive power and US resulted in having more weaker one. The above shows us very interesting contrast between two main capitalist countries. Saying more ironically we can say the economic connections between US and Japan in the past times, look like ones between Japan and Asian Nies (especially Korea) in these days. I cannot help guessing that this fact was caused by admirable trick of history.

Let's go back to our original subject, oligopoly in rivalry. The followings are about characters of rivalry of the concerned industries. The main difference between competition and rivalry consists in the degree of attaching an importance to competition of price. Rivalry holds good to make clear non-price situation. In this kind of situation a pretty high rate of demand-growth lead up to sharp rivalry of technological development, whether the kind of intermediate products are by captive method or non-captive one. The advantage of competitive power used to realize an experience rule of cost (a kind of learning by doing) as well as a large economic merit from economy of scale and technological innovation (process innovation and products innovation) with enormous amount of investment for plant and R&D. This is such a technological development war as we cannot even imagine easily. The drastic price-cutting rivalry follows during the war and after the war as might be expected. In practice every semiconductor company is an imperfect integrated maker unlike so-called big steel company with a perfect integrated operation. Generally speaking a company which vertical integration is highly organized has surely more productive efficiency. Actually most of Japanese semiconductor makers are well-integrated and giant general-electronic appliances companies. This is noticeable feature of Japanese companies. Needless to say even Japanese large makers have to buy the specific production apparatuses and parts from the other excellent family partnerships. As we know a theory of the comparative advantage in the integrated organization hasn't been fully understood even among organizational scientists. A whiskey/beer maker whose main product is whiskey can invest the part of money earned at the whiskey branch into the beer branch. In the same way an electric appliances company whose

main products are home-electric ones can invest the money earned at the concerned branch into the semiconductor branch. This is a secret of safe investment.

What is the theoretical framework explaining this chain of industrial features? In summary it seems there are three vital points. The first is organizational vertical integration. The second is investment for R&D and plant induced by superior cost performance. The third is strategic rivalry in terms of share of sales. All of three points are supply side factors. Besides we must add more three realistic points here. The fourth is what is something like "barriers to entry" in this industry. The fifth is probability of cooperative R&D activities founded by several domestic or/and foreign companies. The sixth is effectiveness of 'industrial policies' characterized by MITI (TSŪSANSYŌ) in Japan<sup>(4)</sup>. If we can safely describe a reliable procedure which coordinates the above six factors, we may make great progress in this industrial research.

### § 3 industrial character seen in the statistical data

At first we will begin with seeing actual situations of the concerned manufacturing industry in the world. By table T-1, during about 20 years sales ranking specially between Japan and US changed dramatically.

Table T-2 tells us that during only five years shares of sales between two countries were turned nicely. This couple of tables show us that US has allowed Japan to take the lead willy-nilly in this industry. This is a hard-boiled fact. And the figure 2.8 (1988) filled in "others" in table T-2 explains symbolic strength of Asian Nies.

According to table T-3 the shares of exports in Japan and Asian Nies

T-1 sales ranking of semiconductor maker <sup>(5)</sup>

company		ranking (1990)	ranking (1971)	sales (1990) (million dollars)
NEC	(JAP.)	1	6	4,952
TOSHIBA	(JAP.)	2	below11	4,905
HIDACHI	(JAP.)	3	7	3,927
MOTOROLA	(US)	4	2	3,692
INTEL	(US)	5	1	3,135
FUJITYU	(JAP.)	6	below11	3,019
TI	(US)	7	below11	2,574
MITUBISI	(JAP.)	8	9	2,476
MATUSITA	(JAP.)	9	below11	1,945
PHILLIPS	(EUR.)	10	below11	1,932

Source: Inquiry of DATAQUEST INC.

T-2 change of share of sales (in the world)

	1983	1988
Japanese Companies	36.8%	51.0%
US Companies	52.4%	36.5%
European Companies	10.0%	9.7%
Others	0.8%	2.8%

Source: Inquiry of DATAQUEST INC.

T-3 change of exports of hi-tech. products

	1980	1986
US	30.6%	26.4%
Japan	8.0%	15.6%
EC	43.5%	37.7%
Asian Nies	4.1%	6.1%
Others	13.8%	14.2%

Source: JETRO (1989)

(including Korea, Taiwan, Singapore and Malasia etc.) have grown while those of US and EC have reduced.

Table T-4 tells us that the composition of final demand (use) of

semiconductor is considerably different in character between two countries. While the weight of government/defence use is 21% in US, the weight of industrial civil use is only 7% in the same country. In the case of Japan the situation is just reverse. In automobiles use the percentage of US is about three times as high as that of Japan.

Next how about applying for patents (technology proper) done in foreign countries by Japanese scientists ?

Table T-5 shows us that the growth of applying for patents done in US by Japanese scientists is large as compared with the same ratio of other countries. As no doubt US is much endowed with seeds of technological ideas and opportunities for economic activities, a field of economic activities using market powers is still immensely large. That famous Kilby's patents concerning semiconductor technology became

T-4 comparison: final demand (use) of semiconductor

	Japan	US
industrial civil use	43%	7%
computers & others	33%	36%
industrial other use	11%	14%
automobiles	3%	10%
government/defence	0%	21%

Source: Inquiry of EIAJ/WSTS (1989)

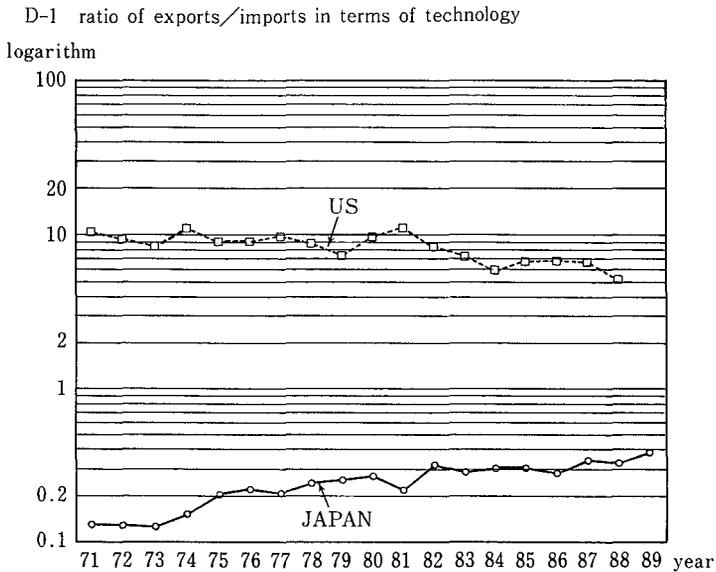
T-5 change of applying for patents by Japanese scientists

	1975	1988
in US	8.5%	20.3%
in Germany	7.2%	13.6%
in UK	6.8%	13.9%
In France	6.0%	13.9%
in Switzerland	4.1%	6.9%

Source: Inquiry of WIPO

old-fashioned now, but most of Japanese semiconductor makers using his patents for their own products are paying a large sum of the patent fee yet. While the rate of applying for patents by Japanese scientists is increasing now, the above fact is even an inevitable troublesome weakpoint for Japanese technology.

Diagram D-1 shows us a ratio of revenue and expenditure (divided exports by imports in terms of trade of technology). The level of US is absolutely high comparing with that of Japan now<sup>(6)</sup>. But while the ratio of US is decreasing, that of Japan is increasing. The above is a symbolic fact, whether we like our notorious technology originated from imitation or not.



Source: Economic White Paper (in 1991)

#### § 4 scale of investment for plant and price change

The above facts mentioned as statistical data are especially interesting for us. But even if these things tell us an material of industrial decline in US, they aren't the vital matters in discussing competitiveness or rivalry of the concerned industry. What can we do on this occasion ?

I am much interested in a so-called product cycles mechanism. This mechanism teaches us that product innovation is more important strategic factor than production process innovation. I believe we can win more valuable theory through modifying somewhat the original version of this theory. In the case of semiconductor industry an interval of the concerned product cycle is extremely short. It is said that the cycle period is three or four years. For instance DRAM market has a specific pattern that its cycle might to dash into the declining-period as soon as four years pass since the manufacturing makers declare selling this product. And the degree of integration used to become four times what it was every three years<sup>(7)</sup>. The integrated degree is the higher, the larger amount of investment for plant is needed. In fact total sum of investment in this branch is just like astronomical figures.

Table T-6 shows us the sum of investment for plant about ten makers in the world. There are two big mountains in 1984 and 1990. In 1987 there is a bottom. The sum of investment in 1984 is larger than that in 1990. About in 1984 the big makers began to set regular mass-production of 256k (DRAM) product. In 1990 they began to set regular mass-production of 4M (DRAM) product. The beginning year of regular mass-production of 1M (DRAM) product is in 1987, but the sum of investment for plant is considerably small in comparison with the other two beginning

T-6 sum of investment for plant

		(hundred millions yen)		
company		(1984)	(1987)	(1990)
NEC	(JAP.)	1,400	400	1,050
TOSHIBA	(JAP.)	1,480	700	1,050
HIDACHI	(JAP.)	1,300	400	950
FUJITYU	(JAP.)	1,310	400	1,000
MITUBISI	(JAP.)	700	160	690
MATUSITA	(JAP.)	1,100	220	730
		(millions dollars)		
MOTOROLA	(US)		320	650
INTEL	(US)		300	670
TI	(US)		210	760
SGS-TOMSON	(EUR.)		190	230

Source: Inquiry of PRESS JOURNAL INC.

years of mass-production. In short we can guess that the methods of production of 256k (DRAM) and 4M (DRAM) needed necessarily true epoch-making and break-through technological innovation. Might the technology of 1M (DRAM) be something improved one as compared with the case of 256k (DRAM), as if it is an epoch-making technological innovation ?

If that is true, a certain break-through technology may come every six years. In adapting this cycle we can estimate that the magnification of large scaled integration become sixteen times. By very simple extrapolation we may be able to guess that a regular mass-production using the next coming break-through technology will appear in 1996 on this 64M (DRAM) product. Probably the regular mass-production of 16M (DRAM) product will start in 1993 without so mountainous investment for plant.

Price change of each specific DRAM product is in close relation with each stage of the past three epoch-making technological innovation.

Diagram D-2 shows us that prices of four kinds of DRAM products including 64k (DRAM) are considerably changeable. We can observe that acute falling of the old product's price took place, very soon after the mass-production of the new product owing to epoch-making technological innovation began.

Diagram D-3 shows prospect of each DRAM demand in the world. And can see that in nearly two years after the vivid demand of the new product appeared, the common demand of old product began to decrease.

As a semiconductor chip is the ultimate element in a sense. Therefore the type of market structure is homogeneous oligopoly. As it were it is the same kind of timber or iron frame industry. Can we say these features of market structure with satisfaction ?

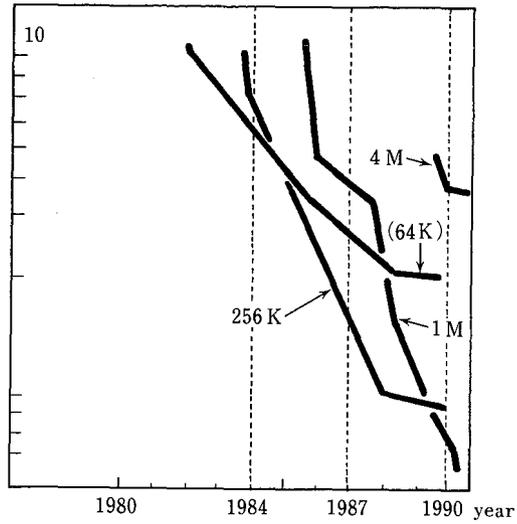
Generally speaking we find that a maker considers two factors in order to acquire his own advantage of competitive power. One is cost structure, the other is product differentiation. The former is price-typed, physical and subjective factor, the latter is nonprice-typed (brand-typed), psychological and objective one. We can write out the following formula here.

price = f (cost, return of investment)

brand = g (sales, rate of share)

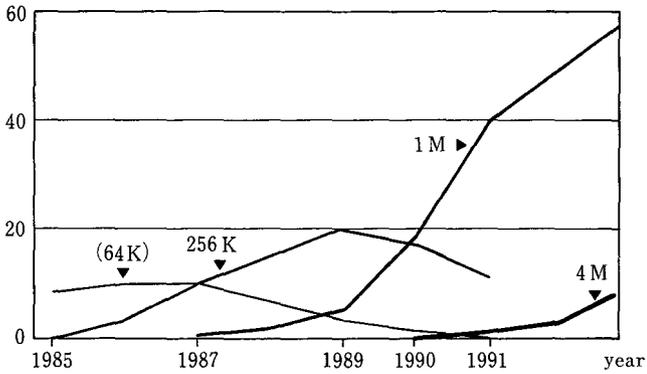
Price is explained by cost and return of investment (ROI). Brand is explained by sales and rate of share (ROS). While the first price formula is written with the help of "average concept", the second one is written with the help of "total concept". While "innovational technology" is the engine which connect cost with return of investment in price formula, "specific performance" is that which connect sales with rate of share. In

D-2 price change of each DRAM product  
logarithm



Source: Inquiry of DATAQUEST-INC.

D-3 prospect of DRAM demand in the world  
(hundred millions pieces)



Source: Inquiry of DATAQUEST INC.

the semiconductor industry "innovational technology" is above-mentioned break-through technology and "specific performance" is height of integration, for instance, named 64M (DRAM). Because price multiplied by quantity is sales, we may say that price has influence with brand indirectly. But true logical relation between price and brand hasn't elucidated as yet.

Though such building materials as timber or iron frame are indispensable to build houses, we don't notice that there are break-through technology in those industries. Besides we don't know that they made an immense cost of advertisement in order to promote the degree of differentiation. It is likely that there are a certain specific homogeneous oligopoly in the semiconductor industry.

To be sure the final purpose of 'going concern' is growth of firm, whether its content is growth of sales or is extension of share or is long-run maximization of profit. But there are four effective properties which Japanese firms have and American firms have not. Two of them are diversification (=non specially occupied in only production of semiconductor product) and skills (=Japanese-typed internal labor situations and man power training). The others are management (=Japanese specific management, for instance, long-run sighted manager and managers' close friendship with workers) and affiliation (=KEIRETU in Japanese: specific transactios among Japanese groups of firms, for instance, HIDACHI group or MATUSHITA group etc.).

Taking so-called 'purposeful systems theory' favorably, there are three concepts which construct a counterpart of firm system. They are structure, function and purpose<sup>(8)</sup>. Structure relates to firm's actions. It contains cost, price, brand, investment and the like as system's element.

Function relates to firm's outcomes. It contains the above four effective properties and advantage of competitive powers (rivalry) including structure itself as a functional subsystem. Environment of a system is a set of elements and their relevant properties which elements are not part of the system.

Table T-7 shows us classes of structure & function in question. In this table MULTI-MULTI in the column means "different structures in the same and different environments". UNI-UNI (A.) in the row means "one function in all environments". UNI-MULTI (B.) means "one function in any one environment, different functions in some different environments". MULTI-MULTI (C.) means "different functions in the same and different environments". And the above each entries are named, in order, "ACTIVE FUNCTIONAL", "ACTIVE MULTIFUNCTIONAL", and "ACTIVE DOUBLE-MULTIFUNCTIONAL".

"SINGLE PROGRAM" means "only market mechanism and process" and "MULTI PROGRAM" means "market mechanism and non market mechanism and process". "ULTIMATE PROGRAM" means "more

T-7 { classes of structure & function }

structure of actions	function of outcomes		
	A. UNI-UNI	B. UNI-MULTI	C. MULTI-MULTI
	ACTIVE FUNCTIONAL	ACTIVE MULTIFUNCTIONAL	ACTIVE DOUBLE- MULTIFUNCTIONAL
MULTI- MULTI only	SINGLE PROGRAM SEEKING (US TYPE)	MULTI PROGRAM SEEKING (JAPAN TYPE)	ULTIMATE PROGRAM SEEKING (JAPAN TYPE in future)

elaborate version of MULTI PROGRAM”.

The last section of this article shows us what Japanese firm system is from the viewpoint of so-called purposeful system.

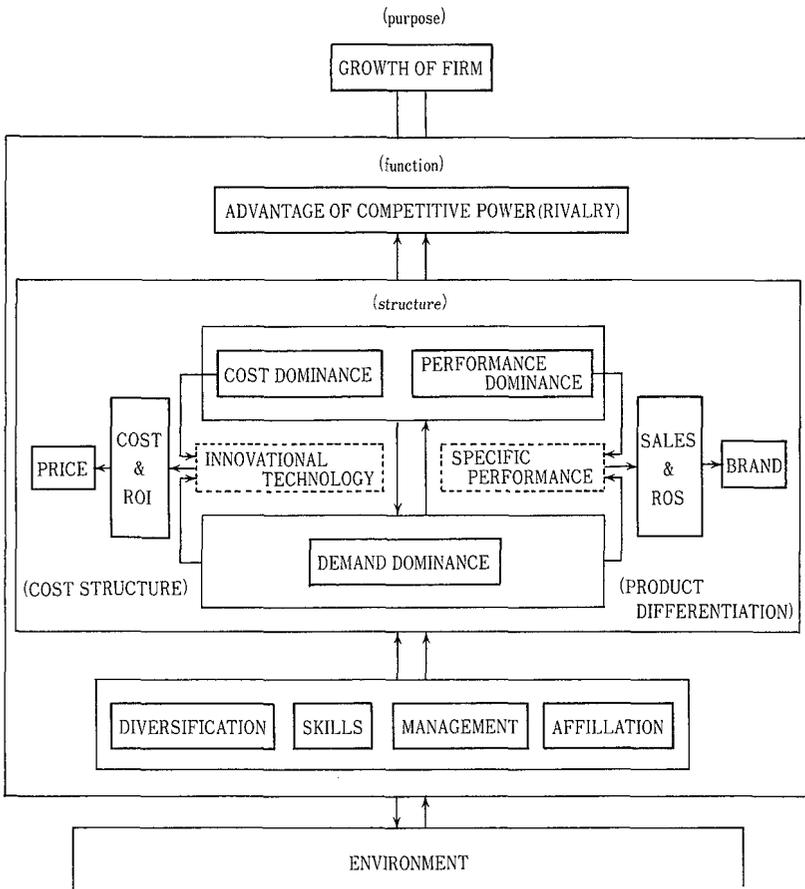
## § 5 conclusion: rivalry in semiconductor industry

Summing up the special features of semiconductor product or semiconductor industry, we can list the following seven features. The 1'st is that it is the ultimate element out of which almost all modern hi-technology products are made. The 2'nd is that in the semiconductor industry the technological goal to attain is evident to persons concerned from the first. The 3'rd is that instead it hasn't a so-called clear-cut brand image of products, the size of demand depends solely on technology concerning the degree of integration. The 4'th is that in this industry an immense amount of investment for plant must be carried out in order to compete with height of integration in intense rivalry. The 5'th is that this industry has a great mass production effect (so-called experience effect) to induce price to fall somewhat. The 6'th is that the concerned world-wide top ranking makers are used to producing a lot of general electro-systematic products including from various kinds of semiconductor devices to radio cassette recorder. The 7'th is that there is a periodicity of every three years in demand change whether the producer likes it or not.

Because of the above seven situations, global business partnership between the same kind of makers is rising in order to complete joint R&D research. This is an effective policy for which the concerned makers decrease their own risk and cost in huge productive investment.

In the near future a handful makers can tide over the keen rivalry and survive through only their reciprocal cooperative partnership. The fresh game between rivalry and partnership has just begun in search of an opening in the advantage of competitive power in the concerned industry. In other words they have just begun to grope for "ULTIMATE PROGRAM" in the above-mentioned table.

《purposeful firm system》



NOTES

- (1) See for instance Warshofsky [1989].
- (2) See Morishima [1984].
- (3) See Kagono et al [1983] and *Keizai Hakusyo* [1990].
- (4) See for instance Okimoto [1989] and Okimoto & others [1985].
- (5) Comparing growth of sales between US and Japan in 1990-91, US is higher by 4 points than Japan (including only top ten makers).

	sales (1990) (million dollars)	sales (1991)	rate of growth (%)
US	9,401	10,727	14
Japan	21,224	23,335	10

Source: Inquiry of DATAQUEST INC.

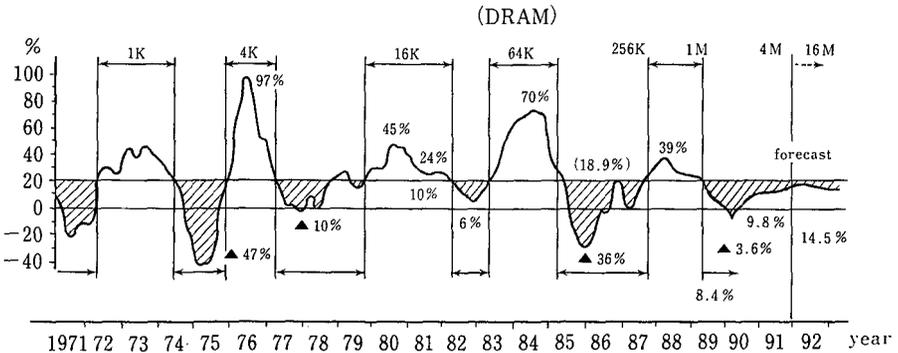
(6) An overwhelming height of level of US is explained by immense amount of patent fee for basic technology proper. "Intellectual property rights" is a coming hot problem.

(7) A representative silicon-cycle mechanism is the followings.

It is said that the literal silicon-cycle doesn't apply in recent trend.

the ratio (in the same period) of the year to last year

— production of semiconductor —



Source: Japanese Mechatronic Industrial Society (1988)

(8) See Ackoff & Emery [1972]. But there are my personal views here.

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