The Slow Consolidation of the Petrochemical Industry

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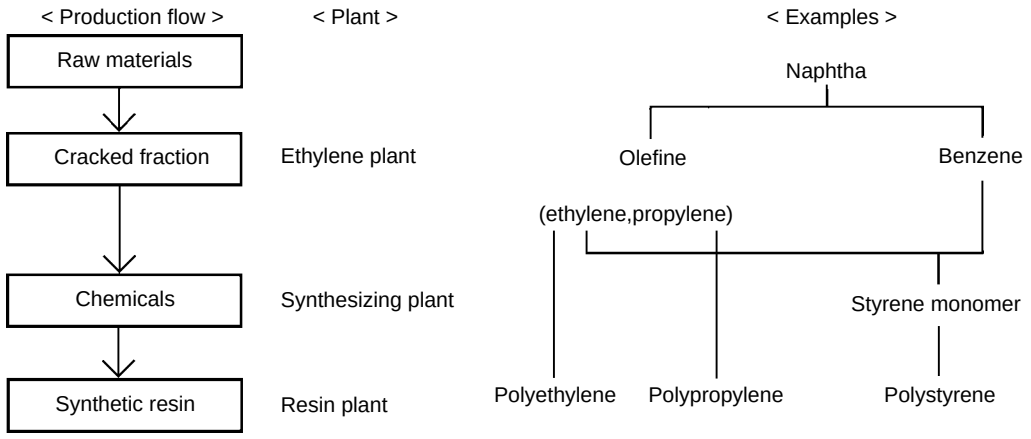
Following the merger announced in late 1993 between Mitsubishi Kasei and Mitsubishi Petrochemical, the petrochemical industry has been restructuring at an accelerating pace. Developments include spinoffs and mergers in the general purpose resin business, and the birth of Mitsui Chemical. Nonetheless, the pace has been slow compared to Europe and the U.S.

For industry restructuring to produce higher earnings, unnecessary facilities that have been preserved need to be slashed. In the future, we should see some companies concentrating on large facilities for general purpose resin, while others will be greatly reducing their upstream ethylene facilities (Figure 1).

Figure 1 Product Flow of Petrochemical Complexes



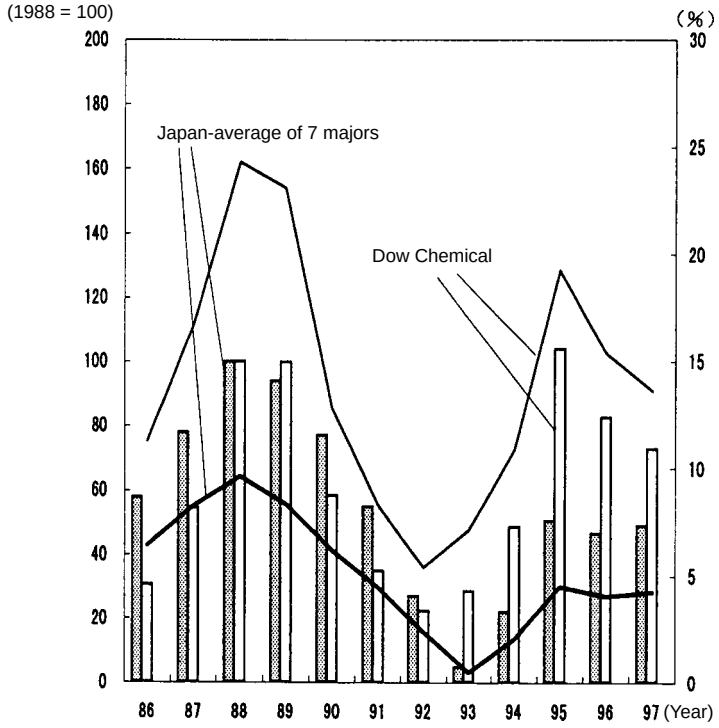
Note: Only examples mentioned in this paper are shown.

1. Backdrop to Low Earnings

In comparing the petrochemical industries in Japan and the U.S., what stands out are the low profit margins of Japanese companies. Japan's seven integrated chemical companies and Dow Chemical, who has a business structure resembling Japanese companies, we see that earnings exhibit similar cyclical fluctuations. In other words, earnings peaked in fiscal 1988 and again in fiscal 1995; they are down at present (Figure 2).

Figure 2 Operating Margins in Japanese and U.S. Integrated Chemical Companies

(Curves depict operating margins (right); bar graphs depict indexed values with FY 1988 as base year of 100 (left).)



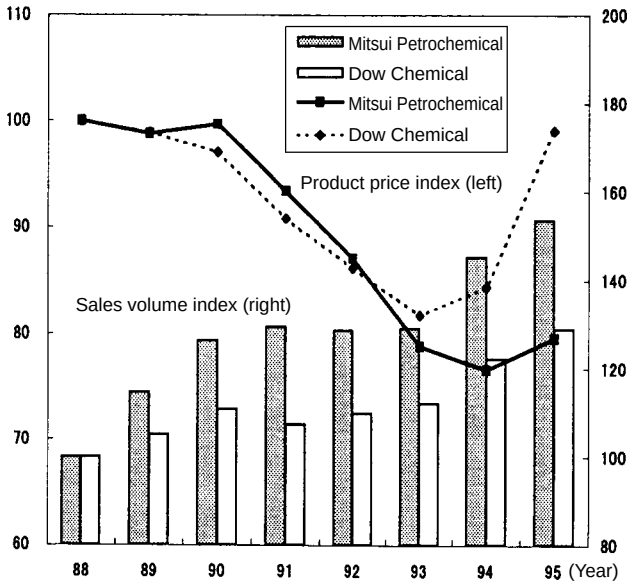
Source: Annual company reports.

However, there is a significant difference between Japanese and U.S. companies in the amplitude of the cycle. Earnings fluctuate more widely in the U.S., with a particularly strong increase in the up cycles. In contrast, Japanese companies show a weak increase in the up cycle, and the fiscal 1995 peak is only about 50 percent that of fiscal 1988.

Moreover, from 1988 to 1995, Dow Chemical posted an average operating margin of 14.1 percent, compared to 4.8 percent for the seven Japanese companies.

The low operating margin can be attributed to a substantial difference in pricing strength. If we compare Dow's petrochemical division with the former Mitsui Petrochemical Industries (now Mitsui Chemical), at the 1995 peak, Dow's prices rose much more than Mitsui Petrochemical's, while volume growth was larger for Mitsui Petrochemical (Figure 3). This reflects the tendency of Japanese companies to pursue volume growth over price increases. The primary reason Mitsui Petrochemical's operating profit dropped 53 percent from fiscal 1988 to fiscal 1995 was a price decrease that greatly exceeded volume increase (Table 4).

Figure 3 Product Price and Volume Indexes for U.S. and Japanese Petrochemical Companies (1988 = 100)



Note: Includes all products of Mitsui Petrochemical, and basic chemical products of Dow Chemical.
Sources: Compiled from annual reports, interviews, etc.

As a result of a market share emphasis in pricing strategy, Japanese companies saw an increase in their ratio of raw material and fuel costs to sales, leading to the large gap in operating margins with U.S. companies (Table 2).

Table 1 Factors Affecting Mitsui Petrochemical's Operating Profit (Change between 1988 and 1995)

Factor	Change in profit (¥ bil.)	Contribution
Change in sales price (A)	-67.4	-203%
Change in purchase price (B)	14.0	42%
Change in terms of trade (C) = (A) + (B)	-53.4	-161%
Change in volume (D)	48.2	145%
Change in fixed costs (E)	-12.5	-38%
Total (C) + (D) + (E)	-17.7	-53%
Operating profit	33.2 →15.5	–

Note: Operating profit excludes royalties.
Source: Interviews

Table 2 Cost Structure Comparison of Japanese and U.S. Companies

Unit: % of sales

	Sumitomo Chemical	Mitsui Petrochemical	Dow Chemical
Fuel & raw materials	61	54	35
Labor	11	10	17
Depreciation	6	5	7
Maintenance	3	3	4
Other	15	23	18
(of which, distribution)	5	6	N.A.
Operating profit	4	5	19

Source: Annual reports.

The gap occurs against a backdrop of a different market structure. Due to radical business restructuring in the U.S., global supply and demand fluctuations are properly reflected in an elastic pricing method. Japan's pricing method is inelastic. This difference is explained below.

2. Characteristics of Japan's Market

(1) Lack of Foreign Competition

The primary characteristic of Japan's market has been the absence of foreign competition. This is due to the following peculiarity of petrochemical products: except for synthesized products such as benzene and styrene monomer, which are liquid at room temperature, most petrochemical products have high freight costs relative to their price, which makes them unsuitable for transacting on a global scale. Ethylene in particular is a basic petrochemical product with high shipping cost because it must be carried in a specially equipped deep freeze ship. For this reason, the petrochemical industry is generally located near the consumption site, and the trading market is limited to the geographic proximity to keep down shipping costs.

Asia, the U.S., and Europe are each basically separate trading markets. Thus until the entry of large South Korean concerns, Japan's market had been unexposed to serious foreign competition.

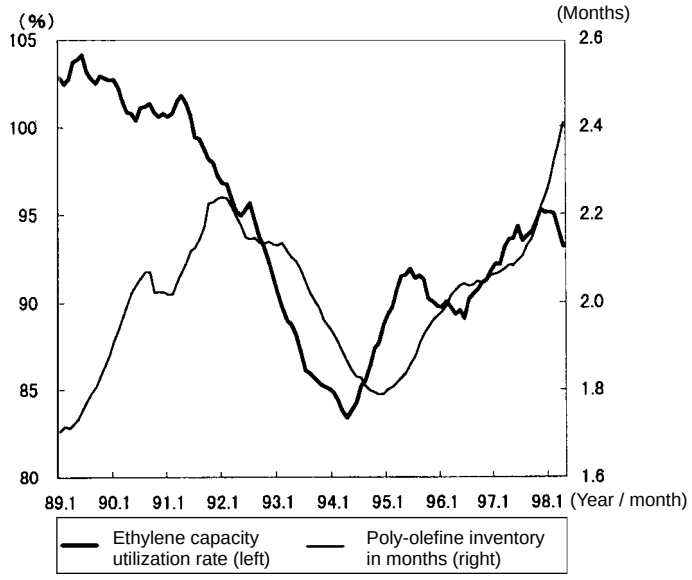
(2) Regulatory Restrictions

In addition, MITI policy has deliberately restricted competition in the interest of maintaining a stable supply. Thus marginal suppliers have been protected even during structural recessions. For example, in the structural recession after the second oil shock, all suppliers were protected from competition by a 1983 law called the Temporary Measures Act for Specific Industrial Structure Improvements.

(3) Difficulty of Concentration

Because the basic process technology in ethylene plants has not advanced significantly, cost differences among plants are small. On the other hand, the freight charge is high. Thus ever since the emergence of the petrochemical industry, Japan built petrochemical complexes in dispersed, independent industrial areas across the country. This makes it structurally difficult to concentrate ethylene plants in a few areas.

Figure 4 Ethylene Capacity Utilization Rate and Poly-olefine Inventory in Months (12-month moving averages)



Note: Poly-olefine inventory in months is expressed as a ratio to domestic shipments.
Sources: Compiled from the *Yearbook of Chemical Industries Statistics,* and data from the Japan Petrochemical Industry Association.

In the U.S. the majority of ethylene plants are connected by the same pipeline network. This means that olefine (ethylene or propylene) can be easily purchased in external markets via the pipeline, and that plants are readily accessible for major restructuring. In Japan, the largest ethylene producing district interconnected by pipeline is the Chiba district with 33 percent of total production, followed by the Mizushima district with 13 percent, and the Kawasaki district with 12 percent. The remaining 40 percent consists of isolated and independent locations.

(4) Priority of Ethylene Production

The difficulty in concentrating ethylene plants results in a structural tendency to produce an excess of general purpose resin. Because ethylene plants are upstream in the production process and form the core of the capital intensive complex, they are operated at high capacity. This inevitably results in the over production of general purpose resin, which is a downstream product. In fact, after running at near full production capacity for three consecutive years to 1997, the

inventory of general purpose resin, the main derivative product, shot up to record highs (Figure 4).

In the several mergers that have occurred in general purpose resin in 1994, the parent companies have continued to operate ethylene plants. Since the ethylene operating capacity of the parent companies is directly linked to that of resin plants, progress in consolidating and reducing resin plants has been slow.

Since 1992, the entry of large South Korean concerns in the Japanese market has also caused changes to the market structure.

3. Foreign Competition in Japan's Market

(1) Convergence to International Price Levels

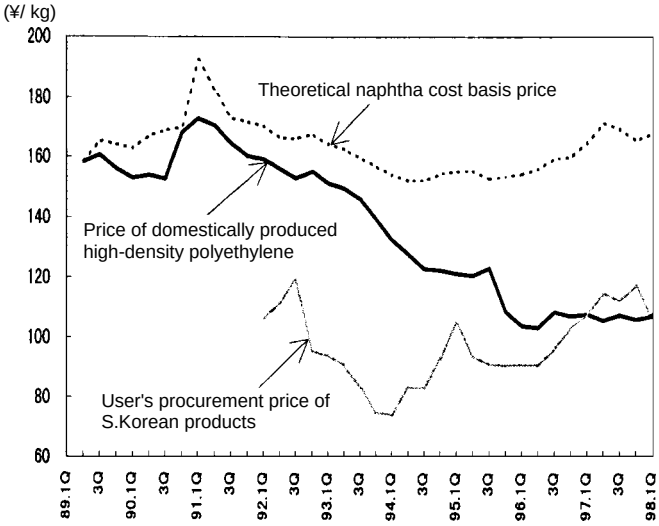
The first change is the decline in prices. For example, the domestic price of high-density poly-ethylene, the raw material for plastic bags, began to move quickly toward the international price level (the user procurement price of Korean products for Japan) after Korean products became readily available, and continued to fall significantly against the cost of naphtha (Figure 5). By late 1996 Japanese products had practically converged to the international price. However, prices did not follow the yen-denominated international prices upward when the yen fell during 1997, creating a reverse price gap between domestic and foreign prices. Japanese product prices are flexible moving downward with international prices, but rigid moving upward. This asymmetry occurs because of excess capacity, which forces companies to emphasize volume over price.

(2) Persistence of Excessive Services

While Japanese product prices converged to international levels from 1992, grade and service differences persisted. Services peculiar to Japan have been preserved, such as the excessive number of grades for general purpose resin and multiple shipments of small lots. In other words, while prices approached international levels, unique services which accounted for high cost structures both inside and outside of plants continued to remain in place.

Japanese companies need to reevaluate their strategies and do the following: (1) overhaul the excessive services so that not only prices but costs fall in line with international levels; and (2) if services are deemed essential, make sure their cost is reflected in the price.

Figure 5 Comparison of International and Domestic Polyethylene Prices and Naphtha Costs



Notes: 1. The theoretical naphtha cost basis price is calculated by assuming that 2Q 1989 product prices are at the appropriate level, and subsequently fluctuate in line with naphtha prices of the previous quarter.
2. User's procurement price of S. Korean products = CIF price
+ Import costs (¥5/kg)
+ Trading co. commission (CIF x 7%, 6.5% from 1996)
+ Domestic freight cost (¥8)

Sources: Estimated based on *Yearbook of Chemical Industries Statistics,* and MOF,*Monthly Trade Statistics.*

(3) Imminent Entry of European and U.S. Companies

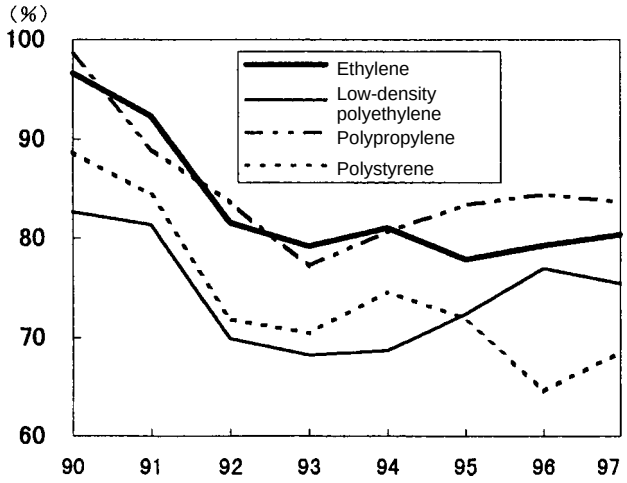
Major western petrochemical companies such as Exxon, Mobil, BASF of Germany, and Dow Chemical are currently building large integrated complexes in Singapore and China for completion in 2000 and beyond. These plants will further accelerate the price decline in Asia and Japan.

Compared to the 400 to 500,000-ton annual ethylene production per plant among Japan's major companies, these new plants will produce 600 to 800,000 tons. In Singapore, ethylene capacity will reach 2.6 million tons per year when the new plants of Exxon and Mobil come on line and add to the existing plants from the merger between Sumitomo Chemical and Royal Dutch Shell. This would create a highly competitive, American style large-scale petrochemical center in Asia. Economies of scale will enable them to become the price leader in Asia's olefine market, as well as have a strong influence on the general purpose resin market.

The Japanese market has basically remained separate from western markets. But in the future, Japanese companies will compete directly against the European and American majors in the Asian market.

With external pressure expected to accelerate the price decline, Japan will not be able to afford inefficiencies arising from excess domestic capacity.

Figure 6 Balance Between Domestic Demand and Production Capacity for Petrochemical Products (Domestic demand / Production capacity)



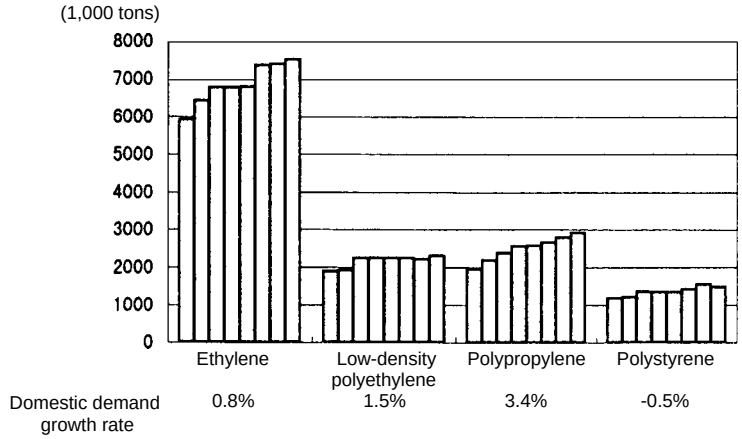
Sources: Compiled from MITI data and *Petrochemical Statistics.*

4. Excess Capacity Becomes Intolerable

(1) Delay in Reducing Excess Capacity

In 1997, production capacity for major petrochemical products exceeded domestic demand by 20 to 30 percent (Figure 6). This excess can be traced back to the prosperous years of 1988 and 1989, when all companies agreed to expand capacity. However, the plants began to come on line from 1992 as demand was slowing down. No major plant reductions have been made as yet (Figure 7).

Figure 7 Increase in Production Capacity and Domestic Demand for Petrochemical Products (1990 - 1997)



Note: Shows annualized growth rate from 1990 to 1997.
Sources: Compiled from MITI data and *Petrochemical Statistics.*

While the industry has consolidated through mergers and joint ventures, plant capacity itself has remained unchanged, causing a condition of excess capacity to persist.

(2) Need for Economy of Scale

Of equal importance as the problem of excess capacity, the scale of production per company is considerably lower than in the U.S.

As stated earlier, the domestic price of general purpose resin is mediated by Asian imports. Let us calculate the revised competitive conditions for domestic producers by including Asian companies that can enter the market, taking polypropylene (PP) as an example. Compared to domestic producers alone, the degree of concentration in production (the combined share of the top three companies) falls significantly, and the average size per company also declines. In comparison to Europe and U.S. markets, not only is the average business size considerably lower, but so is production concentration. With the number of players in the domestic PP market declining from fourteen to seven, this product has seen the greatest industry consolidation. Still, the distribution of companies by production capacity indicates that the top tier remains smaller than in the West (Table 3).

Table 3 Polypropylene Production Capacity by Region and Company Size

(No. of companies)

(1,000 tons / year)	Japan	Asia	U.S.	W. Europe
800 ~	0	0	1	3
700 ~ 800	1	1	1	1
600 ~ 700	1	1	0	0
500 ~ 600	0	0	2	0
400 ~ 500	0	0	1	0
300 ~ 400	3	9	5	4
200 ~ 300	1	9	2	1
100 ~ 200	1	5	0	3
0 ~ 100	0	2	1	1
Total capacity (1,000 tons/year)	2,916	7,471	5,668	7,362
No. of companies	7	27	13	13
Average capacity (1,000 tons/year)	417	277	436	566
Maximum capacity (1,000 tons/year)	738	738	1,018	1,540
Share of top 3 companies (%)	60.8	23.7	41.8	57.6

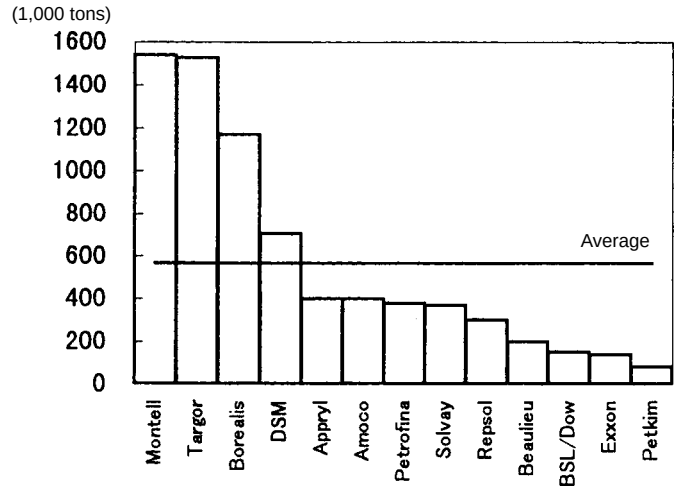
Notes: 1. Calculated based on production capacity at the end of 1997 (1998 estimate for W. Europe).
2. Asia includes Japan, South Korea, Taiwan, Singapore, Malaysia, Thailand, and Indonesia.
Sources: Compiled from MITI materials and *Kagaku Keizai.*

(3) Major Restructuring Cases in Europe

In the West, where large-scale tie-ups began earlier, consolidation across national borders has resulted in a top tier (of about two companies) that is overwhelmingly larger than the second tier. In addition, the number of companies has been consolidated. For example, the top tier in Europe's

PP market consists of two companies: Montell (now a full subsidiary of Shell) from a 1995 merger between Italy's Montedison, the world's top supplier, and Shell; and Targor, from a 1997 merger between BASF, which acquired the PP business of the U.K.'s ICI in 1994, and Germany's Hoechst (Figure 8).

Figure 8 Polypropylene Production Capacity Ranking in Europe (1998)



Source: Compiled from *Kagaku Keizai.*

5. Plant Restructuring and Earnings Improvement

(1) Larger Production Lines for Resin Plants

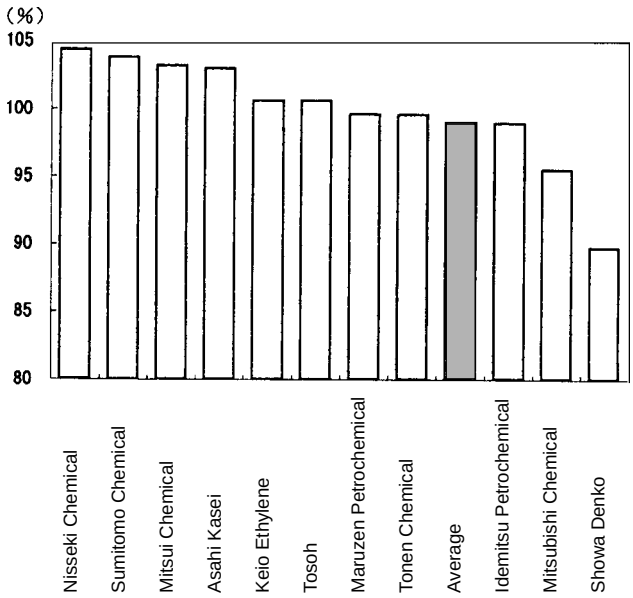
If the integration of resin operations through mergers and joint ventures represents the first stage of restructuring, the second stage will be to abolish aging production lines and lines kept in operation through spot sales, and consolidate lines for grades that can be produced competitively. By drastically reducing the number of grades, companies can carry out replacement investment and concentrate production in high-efficiency, large-scale lines, thereby greatly boosting the cost competitiveness of general purpose products. Sumitomo Chemical has already moved ahead of other with this strategy by completing replacement investment in late 1997 of PP gas phase large-scale production lines.

(2) Abandoning the Full Line Strategy

Considering the industry's priority of maintaining capacity utilization rates for ethylene plants, plant restructuring for general purpose resin will entail reducing excess capacity and the number of companies producing olefine raw material. Reflecting differences in technical and sales strength for derivative products, as well as overall financial strength, some companies will drastically reduce or abolish their ethylene plants and specialize in derivative products, while others will maintain their ethylene plants.

In 1997, compared to the industry's average operating rate of 99 percent for ethylene, the operating rates of individual companies (plants) ranged from 90 to 104 percent. Showa Denko, Mitsubishi chemical and Idemitsu Petrochemical were forced to operate at rates below the industry average due to excessive ethylene plant investment in the late 1980s over and above what was needed for derivative product plants (Figure 9).

Figure 9 Ethylene Plant Capacity Utilization Rates (1997 actual)



Source: *Petrochemical News.*

For petrochemical complexes, the most efficient course is to consume olefine inhouse by producing derivative products with high margins. To maintain ethylene operating capacity by producing derivative products with low margins would be structurally unsound and bound to fail.

(3) Restructuring Complexes Based on Local Ties

To pursue restructuring centered around plants, companies in the same complex will need to coordinate with each other. Strategic tie-ups to concentrate ethylene plants will need to be based on local ties between companies because of the high freight cost for olefine.

For example, the concentration of ethylene plants in the Chiba district, which contains Mitsui Chemical Maruzen Petrochemical, Sumitomo Chemical, and Idemitsu Petrochemical, has an annual production of 2.5 million tons (33 percent of domestic production). In this respect, there is ample potential to restructure along the lines of an American style petrochemical center (Figure 10).

Table 4 Ethylene Production Capacity by Location and Company

(End of 1997)

Location	Company	Production capacity (1,000 tons/year)	Share (%)
Chiba	Keio Ethylene	619	8.2
	Mitsui Chemical	583	7.7
	Maruzen Petrochemical	503	6.7
	Sumitomo Chemical	398	5.3
	Idemitsu Petrochemical	394	5.2
	Subtotal	2,495	33.2
Mizushima	Asahi Kasei	474	6.3
	Mitsubishi Chemical	473	6.3
	Subtotal	947	12.6
Kawasaki	Tonen Chemical	484	6.4
	Nippon Petrochemical	413	5.5
	Subtotal	897	11.9
Kashima	Mitsubishi Chemical	865	11.5
Oita	Showa Denko	738	9.8
Yokkaichi	Tosoh	425	5.7
Yokkaichi	Mitsubishi Chemical	289	3.8
Tokuyama	Idemitsu Petrochemical	474	6.3
Senboku	Osaka Petrochemical	391	5.2
	Total	7,518	100.0

Notes: 1. Production capacity is averaged for years with and without regular maintenance.
2. Subtotals are for zones linked together by pipelines.
3. Keio Ethylene is a joint venture of Maruzen Petrochemical (55%), Sumitomo Chemical (22.5%), and Mitsui Chemical (22.5%).

Sources: Compiled from MITI materials and the *Petrochemical News.*

(4) Need for Common Performance Measure

To coordinate companies and carry out industry restructuring, each company needs to conduct a medium-term competitive analysis and business evaluation using a common yardstick.

Presently, however, only a few companies have developed business evaluation methods that emphasize capital efficiency based on balance sheets for each division. Most companies go no further than managing income statements or a yearly basis, and so are not equipped to perform business evaluations using a common measure.

Given this lack of common performance measures for the industry, even the few companies with advanced financial management have difficulty obtaining an objective perspective of their position relative to competitors. Thus they would be unwise to prematurely scale down or pull out of a market based on their own performance criteria. Instead, they should focus more on long-term strategies.