TECHNION — ISRAEL INSTITUTE OF TECHNOLOGY
THE S. NEAMAN INSTITUTE
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הטכניון - מכון טכנולוגי לישראל
מוסד שמואל נאמן
למחקר מתקדם במדע ובטכנולוגיה

The Chemical Industry 2000

Phase A

The International Chemical Industry and the Israeli Chemical Industry

by
Reuven Wachs
and
Ephraim Kehat

With support from the

Ministry of Industry and Trade, Chemicals and Minerals Administration
via the Manufacturers Association of Israel, Chemical and Pharmaceutical Div.

December 1993

CHNION CITY, HAIFA 32000, ISRAEL . TEL. 237145 / 292329 . FAX 231889 .פקס . 237145 / 292329 .טל . קרית הטכניון, חיפה 32000

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ABSTRACT

The Western chemical industry has been stagnating for many years.The concern over the recent depression delayed the recognition of this structural stagnation.

Data for the past two decades are presented, and correlated with other recorded parameters. Some long term trends are analyzed.

The performance of several large international companies is described, and the apparent unique characteristics of their strategy are presented. The variety of strategies used by the chemical industry in order to improve the return to investors did not result in significant improvements of the profitability or the growth rate for most companies. The chemical industry in the Pacific Rim countries has undergone faster expansion than the Western chemical industry.

The performance of the Israeli chemical industry has taken an intermediate path between the slowed-down Western rate of growth and the impressive growth rate in the Pacific Rim, specially after 1989. However, the increment of the added value in the total value of the chemical shipments is unusually low in Israel relative to other countries, due to a rather low level of integration.

CONTENTS

1. INTRODUCTION

1.1 Objectives

The objective of this study is to identify alternative directions for the development of the Israeli chemical industry in the context of the international chemical industry. Based on such alternatives the needs for educated manpower, research facilities, marketing efforts and raw materials requirements in the near future and later will be identified.

The methodology employed is:

Phase A:

1. A study of the characteristics of the international chemical industry and a more detailed look at a few large chemical companies.

2. A study of the characteristics of the Israeli chemical industry.

Phase B:

3. Identification of the industry segments with a high potential for development.

4. Proposals for alternative strategies for the development of the Israeli Chemical Industry.

5. Estimation of the requirements for research, marketing, educated manpower, and for new raw materials and intermediates for these proposals.

This report covers **phase A** of this study.

1.2 **The Chemical Industry**

The chemical industry has a number of unique characteristics:

The raw materials it uses are important for their chemical properties rather than for their physical or mechanical properties.

It transforms chemicals into other chemicals with a high added value. The transformation may be by made raising concentrations of the main product or by lowering the concentration of impurities, by employing one or more chemical reactions, or by a combination of all the above.
It uses sophisticated equipment, and advanced production, control, and quality control methods.

The investment per employee and the productivity per employee are high, and therefore, highly trained persons must be employed.

In the period of 1984 to 1987, the chemical industry in Western countries underwent considerable restructuring, caused mainly by overcapacity in the production of chemical commodities, and increased construction of chemical commodities plants by oil producing countries of the third world.

This restructuring included closure of older and less efficient plants, exchange of assets between companies in order to increase market share in preferred markets, buying smaller companies, particularly "specialties" companies, purchasing their own shares, in order to boost their stock market value, retiring older employees, and firing other employees, overall reducing manpower by about 15%, reducing R&D in commodities and increasing R&D in emerging fields, particularly in biotechnology.

Since most of the combinations of these restructuring efforts did not increase the profitability of most of the companies in the long term, a second round of restructuring was started in 1991 and continued through 1993. In this round a further reduction of manpower was the dominant feature, but it included more exchange of assets and combined ventures

with other companies, changes in management structures, and reduction of the involvement in some of areas in which the companies invested heavily in the previous decade.

1.3 The Israeli Chemical Industry

The Israeli chemical industry transforms the few local raw materials (Dead Sea brines that include potassium, magnesium, chloride, and bromide ions, and low concentration phosphates), and imported raw materials and intermediates into higher value products.

The Israeli chemical industry is characterized by considerable government involvement as do the Italian and the French chemical industries.

This involvement takes the forms of ownership of major parts of the industry, support for investment and R&D, and price controls, particularly for fertilizers for the internal market (unlike dumping, the internal prices are lower than the export prices).

Other specific characteristics of the Israeli chemical industry are: Political, instead of professional considerations in the appointment of the higher levels of management, control of wages by the government, and the Union, interference of the Union in management decisions, and practically no R&D in small and medium sized companies.

The general market crisis in the eighties combined in Israel with very high debt that was the results of high interest rates at the height of the high inflation period. The restructuring of the Israeli chemical industry resulted in some reduction in manpower, However, government and Union interests did not permit mass manpower reductions or closure of inefficient plants.

The government decided to sell the government industrial companies, but the politicians managed to delay the implementation. The financial crisis of the Union's industrial complex did not permit continued investment in the Union's chemical companies for the duration of the crisis.

In the next sections the global chemical industry and the Israeli chemical industry will be discussed at length.

2. THE CHEMICAL INDUSTRY

2.1 Definitions of the Chemical Industry

There are many definitions of the chemical industry, and it was necessary to agree on a consistent set of definitions at the start of this study.

A useful comparison of the most used definitions is given by Kline (1). He shows that there are at least two definitions of "Industrial Chemicals" and in addition definitions of "Chemical and Allied Products," and "Chemical Products". A more comprehensive definition: "Chemical Process industries (CPI)" includes industrial chemicals, the food industry, rubber and plastic products and additional products, utilizing chemical processes for their production.

The definition of the Chemical Process Industries, as used by Chemical Week is (2): "CPI includes Chemical and Allied Products, pulp, paper and paperboard, processing of petroleum and natural gas, rubber and plastic products, products of stone, clay and glass, primary non-ferrous metals, sugar refining, wet corn milling and similar processing of food and beverages, textile dying and finishing, leather tanning, dry cell & storage batteries, semiconducting materials, carbon and graphite products, hard surface floor covering.

There is no accepted definition of CPI in Israel, but it can be constructed using the usual classification, by adding the categories (3)

10	Mining and quarrying
11,12	Food and beverages
132	Synthetic fibers
150	Leather tanning
17	Paper and paper products

19 Rubber and plastic products
21 Non-metal minerals
20 Chemical industry
222 Non-ferrous metals

The statistical publications of the United Nations statistics (5) use the ISIC code, of which categories 351 and 352 roughly correspond to the definition of Chemical and Allied Products:

351 Basic industrial chemicals (including fertilizers, pesticides and synthetic fibers)
352 Other chemicals (including paints, varnishes, soap and toiletries, drugs and medicines).

We have used for this study the American definition of Chemical and Allied Products consists of the following categories:

281 Industrial Chemicals,
282 Polymers,
283 to 287 and 289: Other Chemicals and Allied Products.

This list includes:
Pharmaceuticals, detergents, servicing materials, polishing preparations, toiletries, cosmetics, paints, coatings, fertilizers, printing inks, carbon black, adhesives, additives, catalysts, industrial chemicals and synthetic materials.

For the Israeli data we have used category 20 used by the Ministry of Industry that includes:

200 Basic Chemicals
201 Pharmaceuticals
202 Soap and cleaning agents
203 Cosmetics
204 Paints and Lacquers

205 Pesticides and Disinfectants

206, 208 Other chemicals (including petroleum distillates)

However, potash and phosphate rock are listed under category 10, (mining and quarrying), and were included in the definition of the Israeli chemical industry in this report.

2.2 Scope

2.2.1 Size and share

The chemical industry is the supplier of materials for other industries and for other segments of the economy, including agriculture, plastics, textile, metallurgical and pharmaceutical industries. The chemical industry supplies performance chemicals for high tech industries such as the electronics, and the modern ceramics industries. Consumer and household goods are also supplied by the chemical industry. Other products of the chemical industry are: food additives, explosives, propellants, etc.

Historically, whenever the supply of natural materials for some particular need became limited, and the technological basis for production of the missing materials was at hand, the chemical industry stepped in, to supply the materials and to enable the downstream industry to develop. This was the basis of the explosive development of the chemical industry, the establishment of the synthetic dyes and drugs industries in the mid-nineteenth century, and the the establishment of the pesticides and polymers for plastics and fibers industries in the mid-twentieth century. The performance of the chemical industry in the world (based of the value of shipments) in 1991 is shown in Table 1.

TABLE 1

The chemical industry in various countries

Sales in 1991 (4,16,11 (chaps. 4 & 5))

Country	Sales $MMM
USA	287.5
Japan	180.0
Germany	100.0
France	66.1
UK	51.0
Italy	50.3
Spain	38.4
Belgium	27.9
Netherlands	24.3
Switzerland	15.4
China	40.0
Singapore	3.0
S. Korea	20.0
Taiwan	
Israel	7.0

The share of the chemical industry in value of the total manufacturing value varies in different countries between 8 and 14%, a rather high fraction.

Neglecting the values of the inputs to the processing causes some distortion when calculating the share of the value of shipments in the form of chemical industry in the total economy, since many chemical products go through interim stages of processing a number of times on their way to the final consumer product. The price of the raw materials will influence the value of the shipment, causing a bias in comparison with products that use cheaper raw materials. These two possible distortions are avoided if the data are presented in the form of added value accounting, which deducts from the value of shipments the value of the raw materials, and other purchased values used for the production. The ratio of the added value of chemicals relative to the added value of all manufactured goods ranges from 8.3% to 15.2% as seen in Table 2.

TABLE 2

The share of added value of the chemical industry
in the total manufacturing added value (1990) (5,6).

Country	Total Manufacturing added value $MMM	Total chemicals added value $MMM	Ratio of added value of chemicals to total mfg	Year of data
USA	1,308	156	11.9	1989
Japan	872	87	9.9	1989
Germany	427	56	13.1	1989
France	204	22	11.1	1991
UK	180	22	12.2	1990
Italy	112	17	15.2	1991
China	111	14	12.6	1989
Spain	66	9	13.6	1991
S. Korea	66	6	9.1	1988
Switzerland	57	9	15.8	1990
Netherlands	54	7	13.0	1990
Belgium	33	6	18.2	1991
Denmark	19	2	10.5	1991
Singapore	12	1	8.3	1990
Israel	9	1	11.1	1988

The share of the chemical added value in the total added value of manufactured goods is fairly constant in the world, and is rather similar to the share of the value of the chemical shipments in the total value of manufactured products. This might suggest that there is no real need to differentiate between those two indicators. However, when the ratio of the chemical added value to the value of chemical shipments for each of the countries in Table 2 is calculated, some interesting differentiations can be seen in Table 3:

TABLE 3

The share of added value in the shipment value of chemicals (5,6,11)

Country	Chemicals added value $MMM	Chemical shipments $MMM	Ratio of added value to shipments (%)
USA	156	288	54
Japan	87	180	48
Germany	56	100	56
France	22	66	33
UK	22	51	43
Italy	17	50	34
China	14	40	35
Spain	9	40	23
Switzerland	9	16	56
S. Korea	6	20	30
Netherlands	7	24	29
Belgium	6	29	21
Denmark	2	4	50
Singapore	1	3	33
Israel	1	4	25

The countries can be grouped by the added values:

1. A group with 40-60% ratio, consisting of USA, Germany, UK, Denmark, Switzerland and Japan.

2. A group with 30-40% ratio that includes France, China Italy, South Korea, and Singapore.

3. A group with 15-30% ratio that includes Spain, Belgium, Israel and the Netherlands

Higher values indicate a developed industry, vertically integrated, which starts from cheap raw materials and accumulates added value on its way to the consumer products. Sales of raw materials and one-step products tend to lower the value of this indicator and the chemical industry contributes less to the national economy, even if the share of the value of shipments is high. Therefore, the weight of the American chemical industry in the US with a 9% value of total shipments share (11) is greater than, for instance, that of Israeli

chemical industry, with a shipments share of 14% (Table 19).

In any case, the importance of chemical industry in the world, especially in the countries of the first group, cannot be overestimated. It should be also noted, that the fast developing South-Asian countries are better placed in this classification, than the fairly developed European countries (and Israel).

2.2.2 The International Character

The international character of the chemical industry is shown in Table 4:

TABLE 4

The largest translational chemical corporations

(1990 figures)(31)

Company	Position in global top 50 List in 1992	Foreign Assets		Foreign Employment	
		$MMM	%		%
DuPont	5	16.0	41	36,400	29
Bayer	4	14.2	56	80,000	47
Rhone-Poulenc	9	13.0	61	50,525	55
Hoechst	2			82,169	48
Ciba	10			69,702	74
Dow	6	10.9	45	28,612	46
ICI	3	10.5	18	78,400	59
Solvay	15	8.1	91	36,578	80

Two of these companies have more foreign assets than local assets and 7 of the 8 companies have 45% or more foreign employees.

2.2.3 Rate of growth

The rate of growth is one of the most important indicators describing industrial activity. It is high when the industry finds new applications, provides answers to new or expanding demands of the economy, supplies to downstream industrial segments that are in the stage

of youthful development. It is low when the industry supplies more of the same, following only the growth of population, or the GDP.

The chemical industry up to 1973, used to lead in fast industrial development, even when it was sometimes accompanied by a drop in profitability (7). The rate of growth of the chemical industry was in the neighborhood of 9% for many years, triple the rate of the general industrial average. For several segments, like polymers, and pesticides, a rate of growth of 15% per year was not unusual (9).

The 1973 crisis that was highlighted by the sharp rise in the price of crude oil, that was not predicted by the best analysts of the chemical industry who, customarily, used extrapolations of the prevailing current prices and production rates.

The change in the rate of growth of the chemical industry was not caused solely by the energy crisis of the 1973, but was also caused by a structural change, some signs of which could have been detected earlier (8).

Soon after 1973 the average rate of growth of the chemical industry dropped to 6%, and later dropped further to the range of 3% per year, loosing totally the advantage over the overall industrial growth rate. (see Figure in chapter 3.3.1)

Since this phenomenon was fairly general for all the industrialized world and since it did not change appreciably for almost two decades, the reasonable conclusion seemed to be that the situation is a consequence of the maturity of the chemical industry, and not very much can be done about it. Today, this complacency may be questioned since the rate of growth in the developing countries of the Pacific Rim is over 10% per year, and the explanation of "cheap labor" is not convincing anymore, and in general does not apply to the chemical industry.

China also joined the fast rate growth countries. Its economic lag is still enormous, but the shear dimensions of this country mean, that a small change will be of a critical importance on a world scale.

Not all countries have followed the pattern of the Western countries. In Israel, although we also had the characteristic drop of the rate of growth in the seventies, the recent growth rate of 5 - 7% per year, is almost double that of the Western countries. It is important to understand the reasons for this development, in order to be able to predict if it is a stable pattern, or a transient event.

2.3 **Trends**

2.3.1 Maturity

The maturity of an industry, characterized mainly by a low rate of development and a reluctance to long term projects and technological innovations, results when its expansion is no longer driven by new and growing applications and when its technological strength is nearly exhausted. The maturity of a consumer industry is easily discernible. However the chemical industry sells mainly to industrial customers or to agriculture enterprises. The degree of maturity of these customers will be reflected in the rate of growth of the supplying chemical industry, and the analysis of the sales targets may be of primary importance. Specifically, a few of the major markets of the chemical industry, such as car production, tire production, home construction, and traditional agriculture in the Western countries have the characteristics of mature industries.

If such an analysis results in the former conclusions, it is unlikely that a mature industry (chemical or non-chemical) will show an initiative for a major change in its market orientation, without an additional external stimulus.

This may be the proper place to insert short quotations from known analysts of the chemical industry, from before and after the crisis of the seventies:

J. Beckman wrote in 1969 (7): "The chemical industry has been among the largest investors in R&D. These expenditures have resulted in a flow of new products and processes that have made significant contributions to the above average growth of the chemical industry and to major changes in its product mix over the years. Synthetic fibers, plastics, gases, synthetic rubbers and many other products have been developed and expanded in relative

importance. Change is the important constant in this industry. For example, Stauffer Chemical estimated that one third of its sales in 1968 was in products added during the preceding five to ten years.

The rapid rate of innovation has had dramatic impacts on competitive patterns within the industry, has created enormous investment requirements and opportunities, and has fed on itself by stimulating an intensification of research efforts by many companies in order to remain competitive. It also has contributed importantly to making chemicals one of the great growth industries in the United States.

Twenty years later D. Garrett wrote (10): "All of these factors show the chemical industry to be very large, with generally slowly rising sales, and steady or declining profits until 1986. Its reinvestment in new capital equipment has been modest, its environmental spending heavy, and its R&D spending not very aggressive, at least compared to its foreign competition. It has become a large and diversified, but mature industry that still has an excellent positive trade balance, but is increasingly having difficulty meeting worldwide competition. It would appear to be in the decision period of its history between allowing a conservative, non-technical or long-range thinking management letting it become slowly more obsolete and noncompetitive (like the steel industry), or continuing to be a more aggressive industry investing in new innovations, processes, and equipment, as a large net exporter".

2.3.2 New technologies

One of the signs of maturity reached by a particular industry is the relative maturity of technologies it uses. The chemical industry was, a long time the leader in modern technologies, like catalysis, polymerization, and the chemical engineering disciplines, driven by the oil and petrochemical producers. However, fast technological expansion and the economy of scale led to over capacity, and this in turn led to technological slow-down. In this respect very little has changed during the past 30 years. A few new significant demands for new materials by dynamic young markets, such as the chemicals for electronics, or ecological demands for new separation technologies and better purification methods gave drive to the development of new products and technologies, but their overall

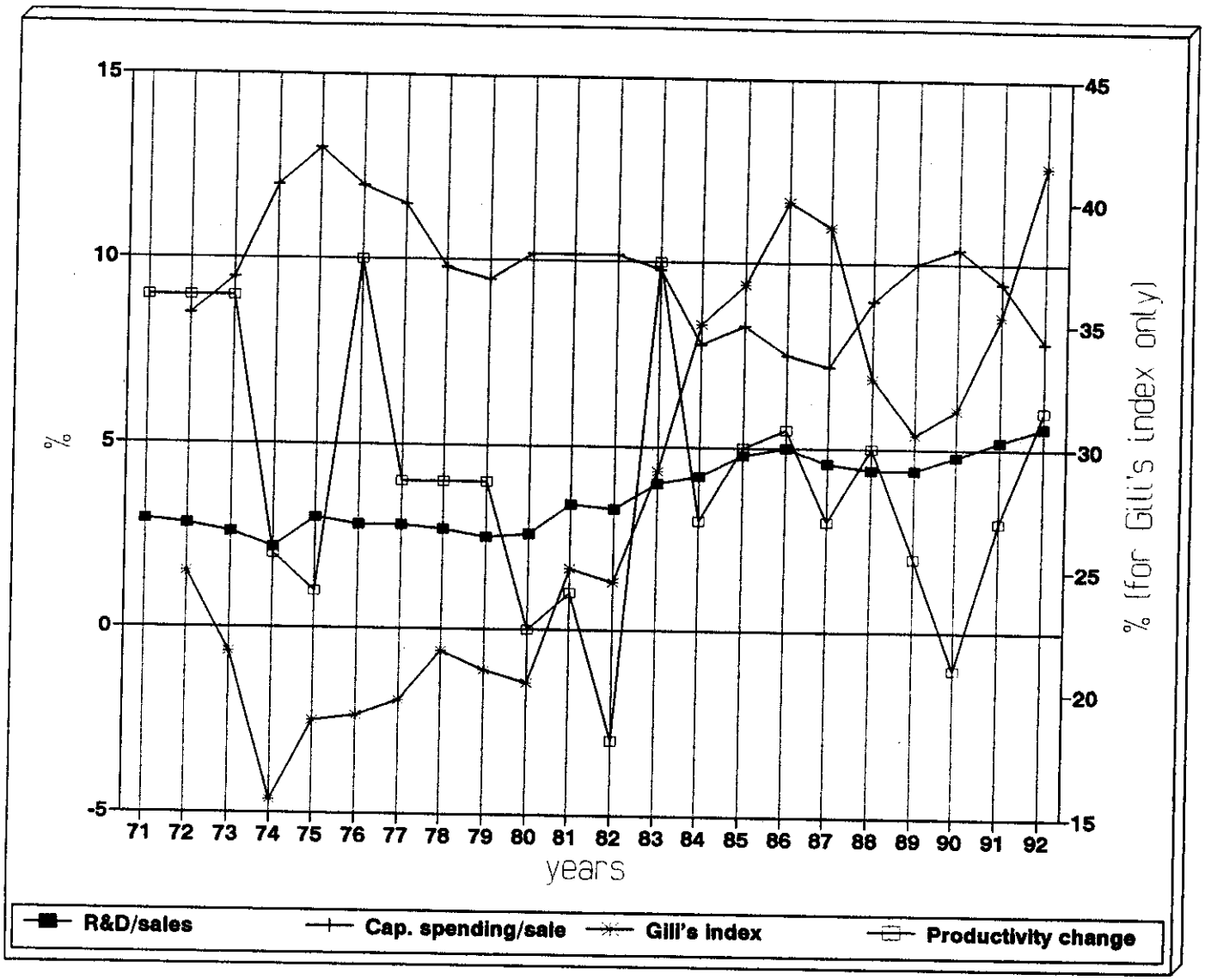
impact on the industry was minor.

2.3.3 Research and development

After a long period of decline, the chemical industry seems to be trying to spend more on R&D, but R&D has not increased significantly relative to sales, despite governmental encouragement (Fig 1). However, the values in excess of 5%, like in USA, are very high in comparison to the average of 1.5%, characteristic for Israel.

The reaction to the 1973 crisis was to increase investment and decrease R&D. From 1975 to 1987 capital investment decreased, then rose till 1990, when it started to decrease again. R&D expenditures rose slightly and almost steadily from 1975. The Gili factor in Figure 1 is an indicator suggested by Dr. G. Fortuna (showing the share of R&D to the sum of R& D and capital investment). The Gili factor rose over the 1974 to 1993 period, with two dips in 1982 from 1989 to 1991. (The data for R&D and capital spending represents only the major corporations).

FIGURE 1 The various factors which may influence the performance of chemical industry in the USA (11).



2.3.4 Profitability

The chemical industry of the industrialized countries is not very profitable. Historically, the situation was different, and the chemical industry was among the most profitable segments of the industry. Backman (7) in his book shows the drop of the profitability during the period of 1956 - 1968 for the pretax margins on chemicals in the USA:

TABLE 5

The pretax profitability of the chemical industry in the US

Year	Pretax Profitability (%)
1956	18.2
1957	17.4
1958	13.5
1959	17.5
1960	15.0
1961	14.6
1962	15.4
1963	15.3
1964	15.2
1965	14.4
1966	13.6
1967	11.0
1968	11.1

Later development for a few companies can be seen in Figure 6, but in recent years the average net profit was less than 10%. In the USA, there was a slight improvement around 1989, and then the average profits plummeted again, to under 5%. The other western countries followed a similar trend.

Many explanations were suggested for this phenomenon: over capacity and exhaustion of the economy of scale. Berenson (12) suggested heavy competition as the reason. He points out that the chemical industry faces five types of competition:

1. Inter company competition
2. Inter commodity competition
3. Inter process competition
4. Inter industry competition
5. International competition

Achilladelis et. al. (13) discuss this pattern of profitability, and explain it as due to the maturity of the industry.

It is often stated, that various segments of chemical industry have different levels of profitability. For instance, fertilizers are assumed to have a profit level of about 2%, and pharmaceuticals of 15%. These numbers are inexact. Even the pharmaceutical industry, which is known to overprice its proprietary products, shows a rather mixed picture, and a few fertilizers companies are very profitable.

Table 6 shows the composite profit margins by chemical industry segment (as % of turnover) for the USA for the relatively profitable years of 1990 -1991.

TABLE 6

USA composite net profit margins by chemical industry segment

(as % of turnover for 1990 & 1991) (14)

Segment	Profit margin 1990 %	1991 %
Industrial chemicals	5.8	3.8
Specialty chemicals	8.7	7.7
Biotechnology	-20	-9
Fertilizers	8.6	7.0
Divers	5.6	3.8
Paints	4.8	3.9
Oil processing	3.9	3.3
Pharmaceuticals	13.8	14.9
Detergents	6.6	5.6

The profits in pharmaceuticals were high, and showed the only rise in 1991. A recent study to find a common factor in profitability of pesticides (15) did not find any common factor in overall performance or R&D expenditures, or sales. The only grouping found was geographical (Table 7).

TABLE 7

Pesticide producer profitability in 1992 (15)

Company	Profitability (on sales)		Sales	
	Range	Rank	$MM	Rank
DuPont	15%-20%	1	1955	2
American-Cyanamid		2	1000	10
Dow Elanco		3	1581	7
Monsanto		4	1647	6
FMC		5	455	14
Sandoz	10%-15%	6	841	11
Ciba		7	2831	1
Rhone-Poulenc	5%-10%	8	1842	4
Zeneca		9	1716	5
Shell		10	725	13
Bayer		11	1869	3
Sumitomo	<5%	12	417	15
BASF		13	1142	9
Schering		14	788	12
Hoechst		15	1333	8

It is probable that beyond the drop of profits, caused by competition, the profits of companies are controlled mainly by the management skills. One of the most important of these skills is the management of continuous change, not a common ability in a mature industry.

There is no reason to believe that the profitability of the chemical industry in the Western countries will change, unless the maturity syndrome is relaxed.

2.3.5 The remedies tried

The structural changes in the chemical industry started in the seventies but were recognized as such much later. Wei (18) who studied the structure of the process industries in 1979, did not foresee any slow-down of the growth rate. Bower (8) in 1986, Achilladelis (13) in

1988, Garrett (10) in 1989, and the study "Made in America" by the MIT Commission on Industrial Productivity (17) in 1989 recognized the structural change.

The remedies, as listed by Garrett (10), are as follows:

1. Cutting costs.

This was possible, as many chemical operations acquired by oil companies were poorly managed. Changing managements and/or ownership and reorganization, sometimes led to lower costs.

2. Staff reductions.

In several cases the massive lay-offs were beneficiary for the companies, but in other cases the engineering, technical or R&D staffs were first to be fired, causing severe long term damage to the company. Luberoff brought the following citation from Investors' Business Daily (19) "fewer than one half the outfits that tried downsizing succeeded in increasing profitability. In addition to the poor souls who were laid off, here are some of the saddest results:

TABLE 8

Effect of restructuring on return on equity (19)

Company	Return on equity	
	Before (%)	After (%)
Eastman-Kodak	12.9	4.5
Zenith-Electronics	8.1	-32.0
Sears-Roebuck	10.8	-2.3
Westinghouse	18.9	9.8
American-Express	15.1	7.1

3. Divestitures.

This went beyond closure or sale of many inefficient units. " In the mid-80s it became almost an obsession, and very large numbers of divisions from many companies were divested." Sometimes it led to a loss of valuable know-how, in many cases going abroad.

One of the theories, supported by the team from MIT, was that the chemical companies have to divest the commodities, and to remain with higher added value products, called "specialties". Forgetting that commodities were the cash cows of the corporations proved to be a mistake.

4. Leveraged Buy-outs.

The buyers of plants under this scheme were a combination of people who worked in the plant with financial backing by financial organizations. Such people were more highly motivated than the corporate buyers, and, therefore, the chances for success were higher. There have not been enough studies to tell if this scheme works in the long run, or whether it results in the control by the financial groups and the birth of a classic corporation.

5. Mergers and acquisitions.

"In the mid 1980s acquisitions (just as divestitures) became almost epidemic." Many mergers and acquisitions were made. Those that increased market share were often successful. However, some appeared to be based on deals meant more to show financial acumen and improve the position of the company in the stock market rather than in the chemicals market. "For instance, Cheseborough-Pond took over Stauffer Chemicals in 1985, was later acquired itself by Unilever, the British -Dutch consumer products giant for $3.1 billions Unilever then sold the Stauffer operation (in 1987) to ICI for $ 1.7 billions, which in turn sold Stauffer's specialty chemical division to Akzo America for $625 millions, and the basic chemical groups to Rhone-Poulenc for $522 millions It is not known who did profit from this chain of transactions, but it did not improve the motivation of Stauffer employees towards more efficient production." Garrett's own definition: "Mergers would appear to be a poor substitute for internal development if management pursues strictly one path or the other, or has no intention of capitalizing on new technical developments"

6. Strengthening existing production.

Commercial activities, economy of scale (when possible), operating and managerial efforts, technical innovations and acquiring new technical skills by buying smaller outfits. The United States has always excelled in the technical improvements, but recently take-overs were taking the place of innovations, particularly in the pharmaceutical business.

possibility of splitting Bayer and decided against it because it would lose some of the synergies." But the company will reexamine the situation every years or so (23).

11. Reengineering

A fashionable trend described in detail in a recent publication (20) is more of a paradigm than a concise system of procedures. It is defined by Hammer and Champy in their book "Reengineering of a Corporation" (21) as follows: "The fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance - such as cost, quality, service and speed.

The basic approach is that the performance should not be only improved but that it should be redesigned. Earlier versions of this approach such as zero basis planning did not attain the catch word broad appeal, as reengineering, probably because fewer people recognized the need earlier. New developments in computer techniques were of crucial importance for success of the Reengineering approach. The computers are not trying "to cut the redundant corners", and computer programs cannot pick and concentrate on the most important priorities, as human analysts do, but can be used to check a wider range of options. For instance, Union Carbide "started its restructuring by changing its entire mindset". The concept is new, and fashionable. Its users will have the opportunity to find out if it is a new name for old tricks, or a new remedy for an ailing industry.

3. THE GLOBAL CHEMICAL INDUSTRY

3.1 Comparison of the chemical industry in different countries.

A compact comparison of the chemical industry in 13 countries is tabulated in Table 9. East-European countries were not included since the fluctuation of the production rates in recent years were influenced more by political changes (sometimes unpredictable) than by the economy. The parameters of the comparisons are:

1. The chemical sales for the last 2 years,
2. The production growth rate for the last 2 years,
3. The mean production growth rate for the last 5 years,
4. The chemical added value for 1991.
5. The ratio of the chemical added value to the chemical sales for 1991.

TABLE 9

The parameters of the chemical industry in different countries (5,6,11)

Country	Sales 1991 $MMM	Sales 1992 $MMM	Prod growth rate 92/91 %	Prod growth rate 91/90 %	Mean Prod growth rate 87/92 %	Added Value 1991 $MMM	Ratio of AddedValue to sales 1991 %
USA	289.0	297.0	2	-2	1.3	156	54
UK	51.1	52.8	2	3	2.5	22	43
Germany	106.3	105.6	1	2	2.5	56	53
Japan	180.0		0	2	2.5	87	48
Italy	51.3	52.0	0	-1	0.8	17	33
France	68.5	68.4	6	2	4	22	33
China	39.6	43.6	10	-1	4.8	14	35
Switzerland	15.8	17.0	4	1	3.0	9	56
S. Korea	20.0		12	12	14	6	30
Spain	39.4	39.9	2	-1	2.5	9	23
Belgium	29.6	29.6	2	0	2.5	6	21
Netherlands	25.0	24.6	2	0	2.5	7	28
Israel	3.8	4.0	9.5	5.1	4.9	1	26

7. Move into higher added-value products.

This much advocated approach in the middle eighties now has many critics. Many introduced specialties serve other mature industries, like oil drilling or textiles and their behavior follows that of commodities. A differentiation between industrial specialties and consumer specialties can be useful, particularly if based on forward integration.

8. Foreign trade and production

This has been a useful approach for the USA, and resulted in a strong surplus in foreign chemical trade balance. However, this surplus was sharply reduced when their main trading partners in Europe went into recession.

9. Diversification

A much recommended approach that showed positive results in many cases, by spreading the risks and balancing seasonally sensitive products. Occasionally it meant branching out of the chemical business, like Allied Chemicals, now Allied Signal. Only in rare cases was the new direction based on real internal expertise in the company, and therefore, the need was more for managerial excellence than for technical excellence. The synergetic effect of several lines of business was often very positive, but sometimes led to excessive strain on the successful products that had to support the newer or weaker products.

10. Demerger.

This newer approach is not yet detailed in books. It calls for splitting the existing organization into separate entities, without divestiture, so that each part can have a different culture more fitting to its lines of products. Each part can also have different marketing, investment and R&D policies. The most prominent case is the split of ICI, but several other smaller companies have made steps in the same direction (22) For example the spin-offs to shareholders at Eastman Kodak, Ethyl and Cytec. J. Roberts, a chemical analyst wrote: " The Ethyl and Cytec transactions, particularly, are efforts to isolate lower businesses that were coloring investors' perceptions of the entire corporation. For example, Ethyl's petrochemical businesses were depressing the value of its lubricants and fuel additives operations". Many other companies are presently studying the possibility of demerger. Manfred Schneider, the chairman of Bayer has declared: "the company analyzed the

The outstanding performance of South Korea should be noted. South Korea has maintained a high mean production growth rate for the last 5 years, with a high ratio of chemical added value to chemical shipments.

China has shown a good performance last year. It is too early to estimate if this trend is a stable one, as some signs of inflation appear there. Israel, with almost 5% of mean annual growth rate shows a better performance than most Western countries, but is lagging behind Korea (and other East-Asian countries, not shown), and was overtaken by China in 1992.

3.2 USA

3.2.1 Growth trends

The US chemical industry is aware that the recent and current slumps are complex. The recipes for change that have been tried have not been effective in most cases. Since the publication of "Made in America" (17) the chemical industry has been urged to divest commodities and to look for specialties with added value. However, non-critical favoring of specialties has not turned out to be a panacea (30), and "downsizing" turned out many times to be outright detrimental (19).

Figure 2 shows the US production indices over the past 22 years, the yearly changes and a 10-year averaged running change, for all commodities and for chemical products. The last shows three drops: in 1973 and in 1982 and a smaller drop in 1989. The 10 year index for chemical products has lost its advantage over the 10 year commodities index. The 10-year running index grew by 9-9.5% for many years till 1973, about 2.5 to 3.5% higher than the all-commodities rise. After the 1973 crisis there was a drop of about 3% in both indices. After the end of the high inflation period in the US, after 1982, both indices converged to rises of abound 2 to 3% per year.

FIGURE 2: US commodities and chemical production indices, 1971 - 1992 (11)

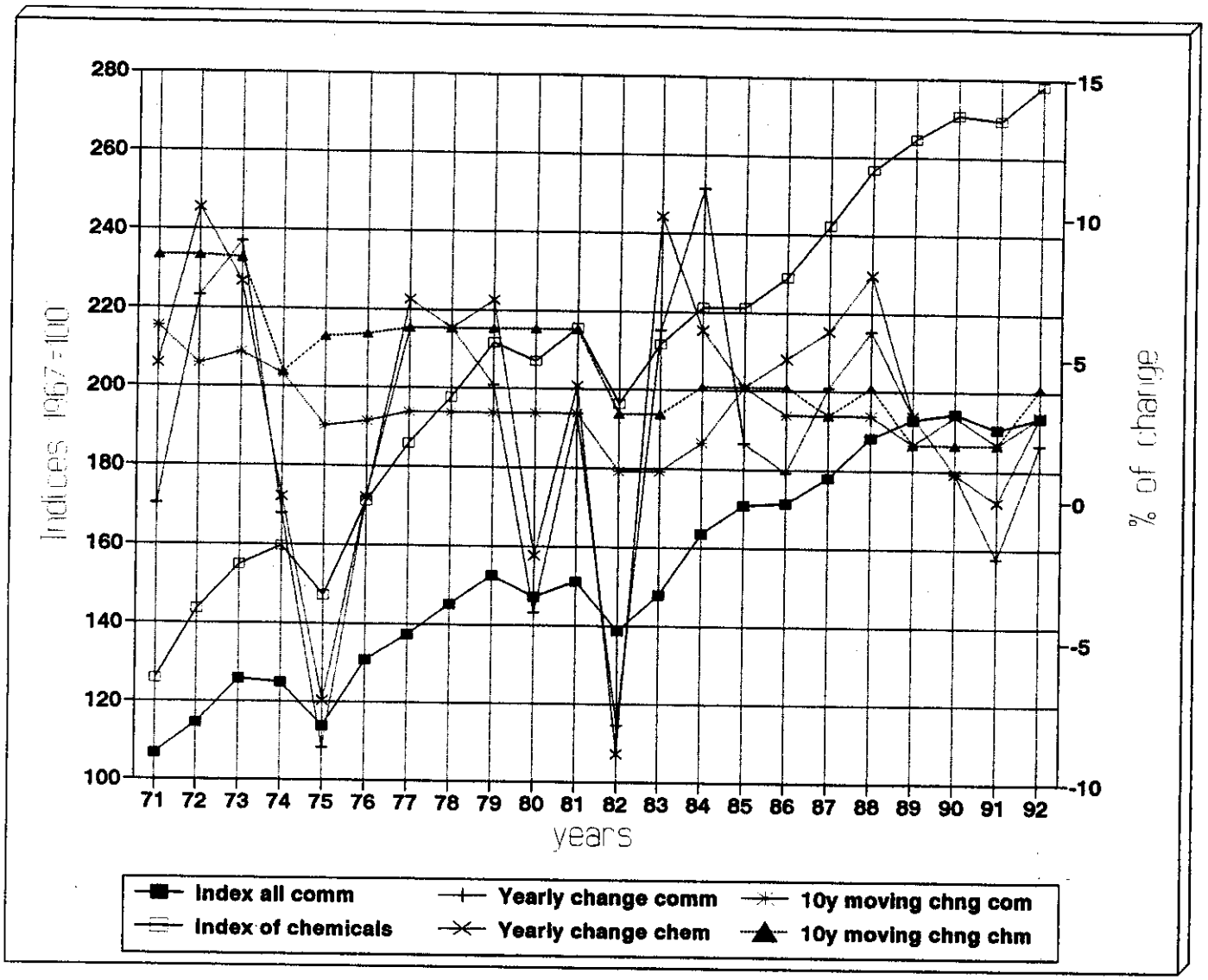


FIGURE 3: US chemical segments production indices, 1971 - 1992 (11)

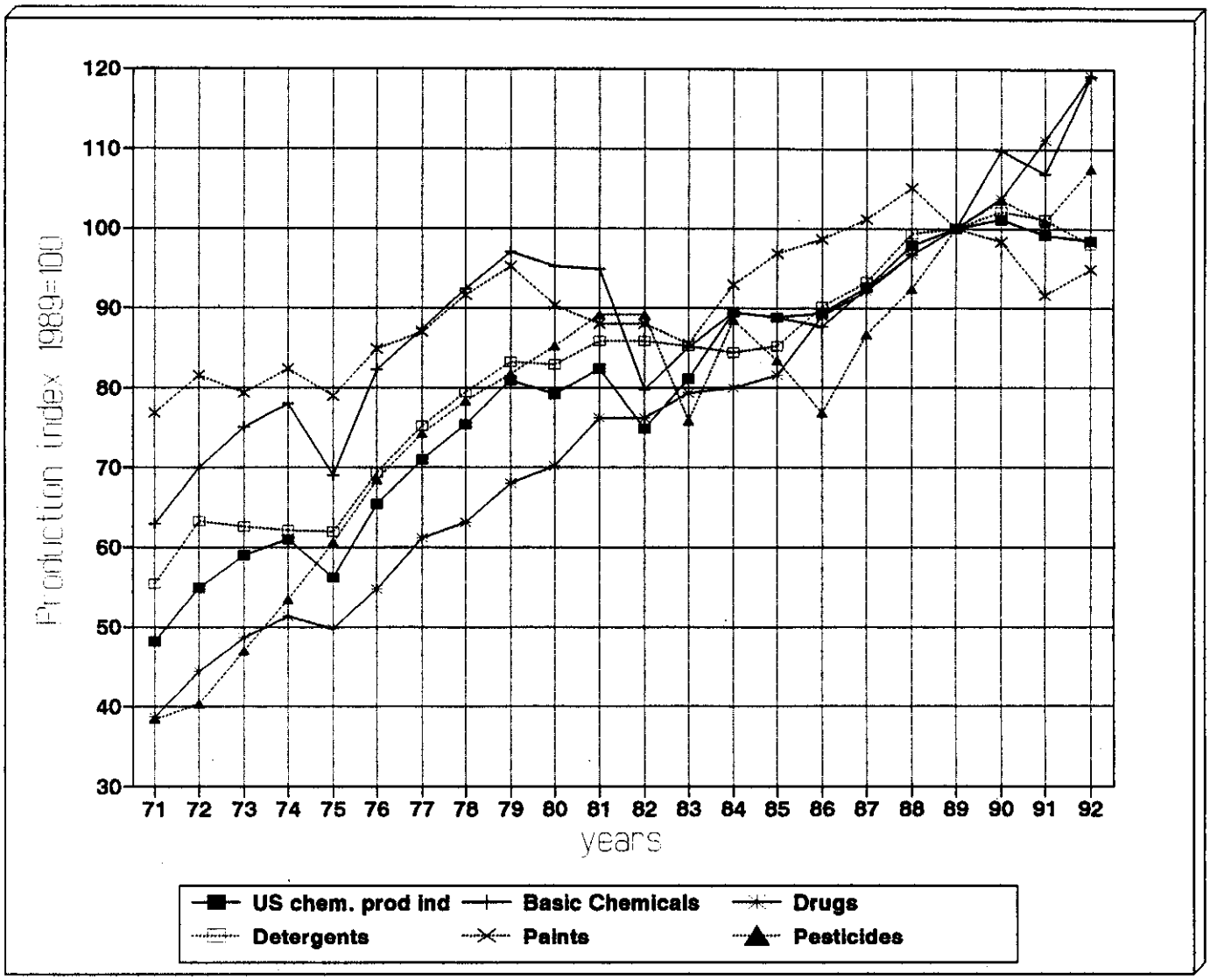
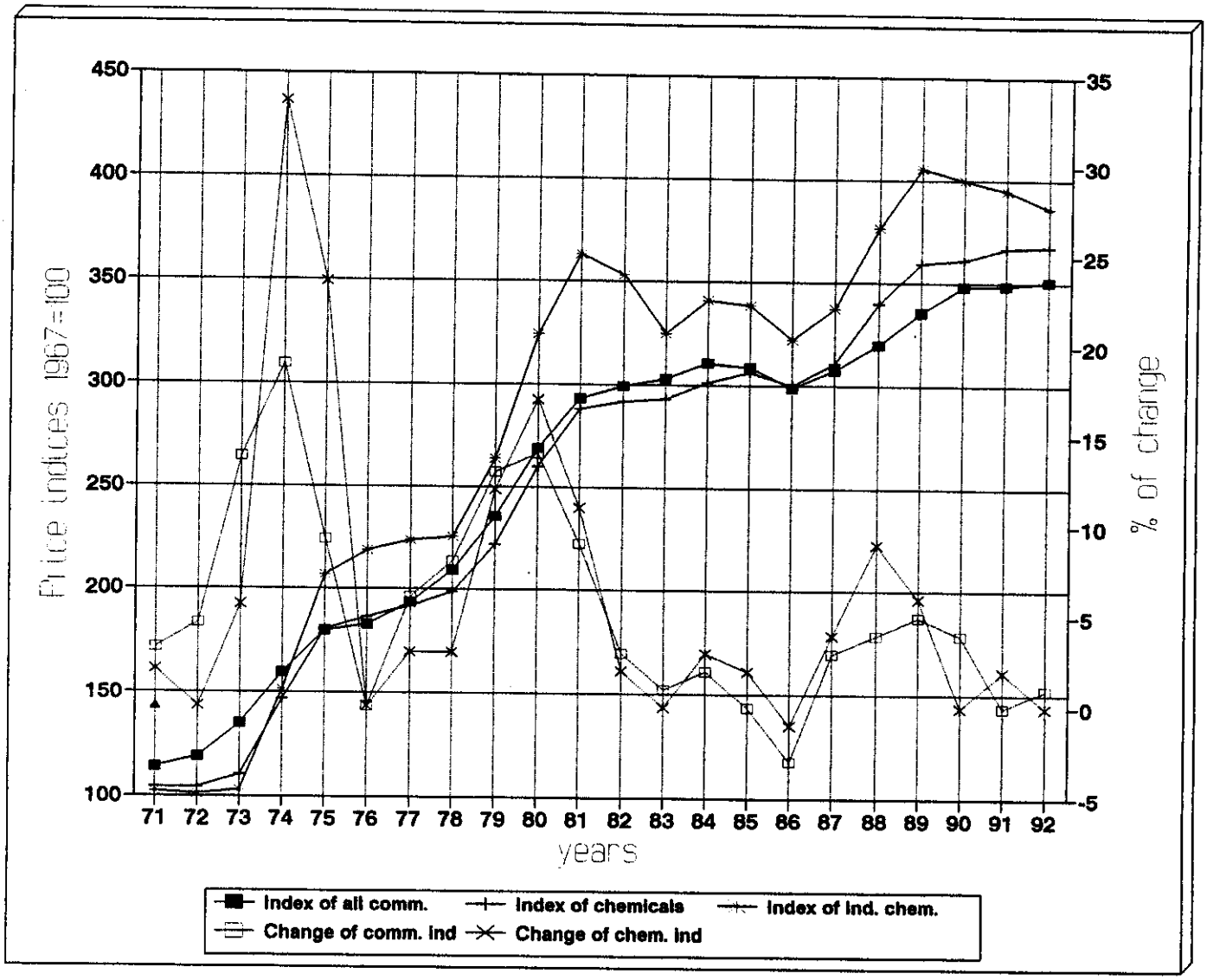


Figure 3 shows the Chemical production index (1989=100) expanded by segments, over the past 22 years. At different years, different segments of the industry rose at different rates. However, over the whole period the greatest rise was for drugs and pesticides.

Figure 4 shows the price behavior of the all US commodities, chemicals and industrial chemicals. The chemicals price index reflects the sharp rise after the 1973 oil crisis, and the 1976 - 1982 inflation, and the "good" years of 1988 to 1991. The chemicals price index was in most years higher than the commodities price index by a small margin. The price index of industrial chemicals, rose faster, with the surge of demand at the end of the high inflation period.

FIGURE 4: US commodities and chemicals price indices, 1971 - 1992 (11)



3.2.2 The large companies

A general overview of the recent performance of the larger US companies is shown in Table 10:

TABLE 10

US Chemical employment and productivity (43)

Company	Sales $MM		Employees		Sales/Employee $M		EBIT Margin (%)	
	1991	1993	1991	1993	1991	1993	1991	1993
Dupont	38,965	37,325	74,611	66,627	522.2	560.1	8.2	8.7
W.R. Grace	2,544	3,008	32,433	25,411	78.4	118.4	15.9	12.7
Dow Chemical	18,807	18,525	24,193	21,300	777.4	869.7	8.9	9.5
Amer.Cyanide	4,986	5,817	17,145	18,298	290.8	317.9	16.0	15.5
Eastman Chem	3,614	4,125	16,915	17,926	213.7	230.1	14.8	12.8
Hercules	2,929	2,826	17,324	15,419	169.1	183.3	8.7	10.8
Monsanto	8,864	7,955	12,200	11,100	726.6	716.7	11.5	10.0
Union Carbide	4,877	4,725	13,184	11,025	369.9	428.6	5.2	7.1
Air Products	2,931	3,300	10,292	10,184	284.8	324.0	14.0	14.3
Quantum Chem.	2,532	2,443	8,930	8,730	283.6	179.8	3.5	4.5
Rohm & Haas	2,763	3,360	8,400	8,000	328.9	420.0	9.0	11.3
Ethyl	1,535	1,795	5,228	4,196	293.6	427.8	15.8	15.2
Dexter	938	892	3,350	3,424	279.9	260.4	10.5	13.0
Lubrizol	1,476	1,536	2,907	2,937	507.7	523.0	10.8	10.3
Lyndell	5,729	4,288	2,270	2,407	2,523.8	1,781.5	7.0	12.5
Ferro	1,057	1,077	2,276	2,314	464.4	465.4	10.2	12.5

The 1993 figures are estimates, and EBIT margins are the earnings before interest and taxes as percent of sales.

The sales figures are the total for the company, but the employment figures are for US employment only. Therefore, the efficiency figures can be misleading. However, since most of the personnel reduction in 1991-1992 was in US personnel, the increase in sales/ employee for companies with decrease in sales can be attributed to personnel reduction.

The sales of five of the largest chemical companies in the US (DuPont, Dow, Monsanto, Union Carbide and Celanese), on the basis of their deflated turnover over the period of 1971 to 1992 are shown in Figure 5. In deflated dollars the performances of Union

Carbide and Monsanto and of DuPont after 1978 are unimpressive. Celanese was bought by Hoechst in 1986 and combined with the other Hoechst holdings in the US, and hence the rise in its performance in 1986 and 1987. The only company of these five to show an improved performance over most of that period is Dow.

The net profits (as % of the sales) for the first 4 companies of the above plus Great Lakes and Bristol Myers are shown in Figure 6. The four larger companies show declining profit margins from 1973 to 1985, a rise from 1986 to 1989 and a decline afterwards. Here again the top performer of the was generally Dow. The two smaller companies showed much higher profit margins than the large companies, but with large fluctuations for the case of Great Lakes.

The performance of Union Carbide, Dow and Great Lakes, will be analyzed in greater detail in the following sections.

3.2.2.1 Union Carbide

The Union Carbide corporation has dropped from the number 2 producer in the early sixties to number 5 today. During that period Dow rose from number 4 to number 2 and is not too far behind the leader, DuPont, in chemical sales.

In its early history at the turn of the century Union Carbide main products were calcium carbide and acetylene. From this starting point it developed 5 main business centers (18)

1. Chemicals, Mainly ethylene derivatives: ethylene oxide, styrene, and vinyl chloride)
2. Plastics: polyethylene, polypropylene, and phenolics.
3. Gases and related products: oxygen etc., molecular sieves, cryogenic equipment.
4. Metals and special carbons.
5. Consumer and related products: antifreeze, batteries, lamps.

Later, the pesticides started to be prominent products (up to the infamous Bhopal disaster). However, there are no clear integration links between the different business areas.

FIGURE 5: Sales of five of the largest US chemical companies for 1971-1992
(in deflated 1967 $)

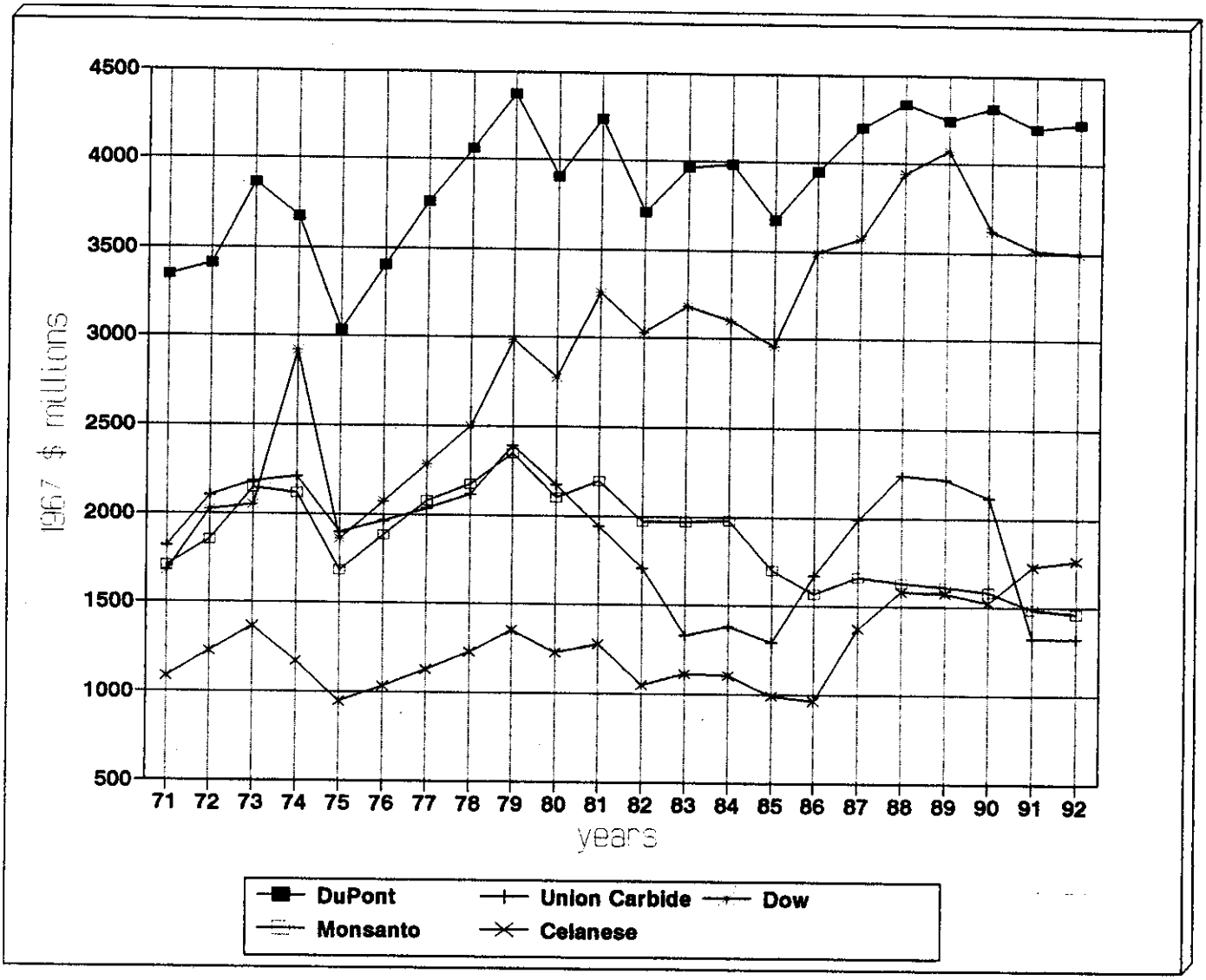
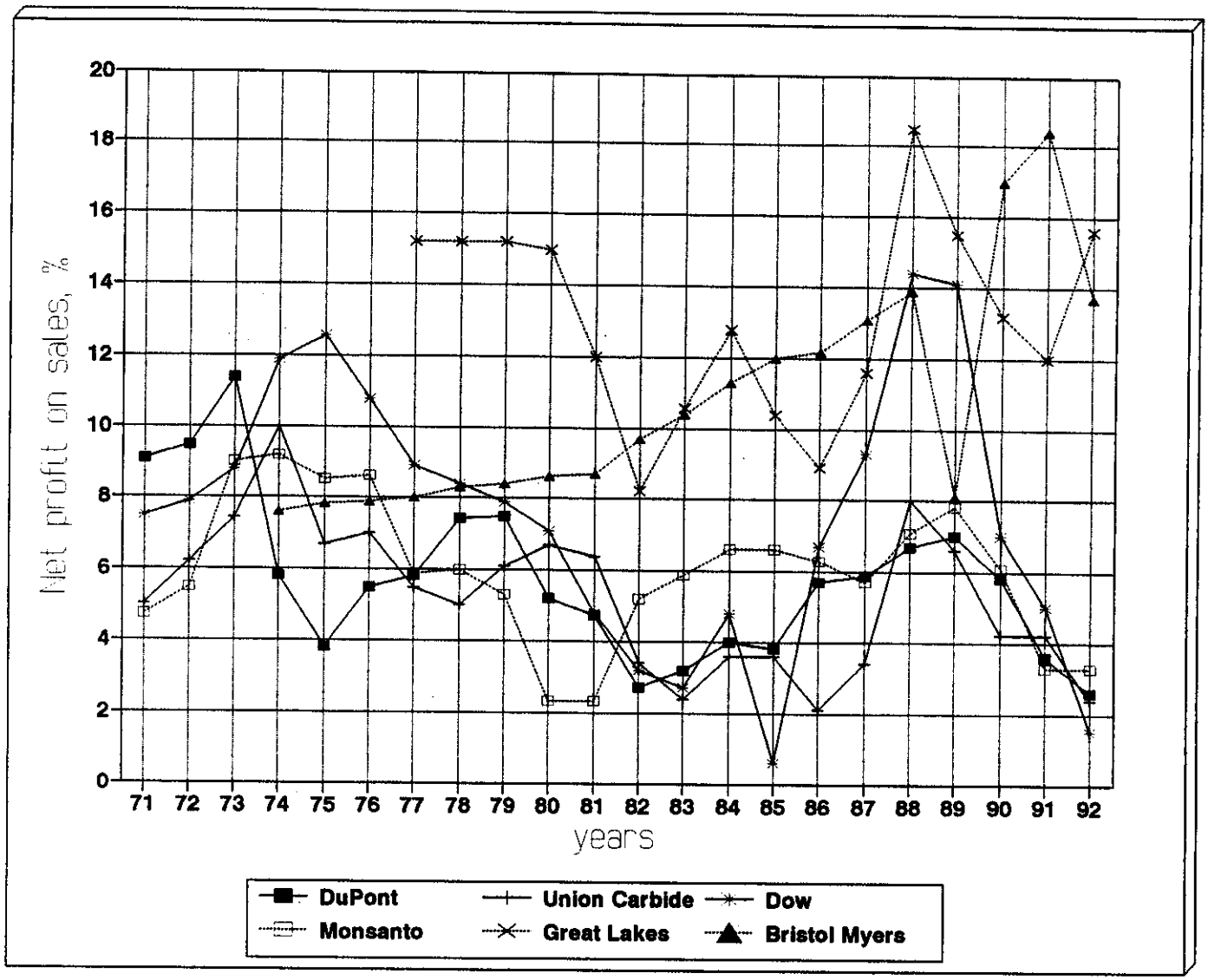


FIGURE 6: Net profits for 6 US chemical companies for 1971-1992 (as percent of sales)



The three basic points of the company strategy (similar to many other companies) were:

1. Strengthening of existing businesses.
2. Withdrawing from areas with little potential.
3. Shifting the product mix towards "performance materials".

This policy gave excellent results till the early seventies.Then two processes began:

1. The oil companies entered the petrochemical field, endangering the polyethylene business.
2. Many chemical companies started to integrate backwards, into the domain of oil companies, in order to fight the effects of the oil crisis, often using highly leveraged financing (8).

Union Carbide dominated the polyethylene business, being a commercial and a technological leader, so it had to maintain its standing. However, it was against its policy to enter the oil business or to take heavy debts. The company financed its attempts to keep its market share by selling its other polymer businesses. In hindsight it was a doubtful move. Table 11 originating from McKinsey & Co., illustrates that the company lost capacity share in all its polymer businesses.

TABLE 11

Union Carbide Capacity Share in Ethylene and Derivatives, 1965-1980 (in %) (8)

YEAR	1965	1970	1973	1974	1975	1980
Ethylene	30.5	24.3	17.4	18.2	16.4	10.7
LDPE	31.1	23.2	18.6	20.2	10.1	16.4
HDPE	13.7	12.6	5.4	5.4	10.5	6.6
Polystyrene	10.7	5.8	6.8	7.6		
PVC	10.3	9.4	6.3	6.1	6.1	2.3

Two other events: retirement from European production, and the Bhopal disaster brought Union Carbide to its present situation, the last among the big 5 of the American Chemical industry.

3.2.2.2 Dow

Dow is the only one among the large US chemical companies to show a significant growth rate (in constant dollars) over the past two decades, as was shown in Figure 5. The strategy of Dow appears to be vertical integration, growing into consumer specialties with high profit margins while not abandoning commodities and industrial specialties and trying to obtain a 1:1:1 ratio among these three classes (24). This strategy is consistent with the importance of the higher added value, without giving up the advantages of scale of a very large company.

Chemical Week (24) explains: "Dow is on track in its strategy for product mix. Several years ago Dow management set the goal to boost specialties to 50% of sales. That strategy has been revamped to differentiate between industrial and consumer specialties. Stavropoulos (Dow's president) says the company is driving for sales divided equally among basics, consumer specialties and industrial specialties. Dow is not far from attaining that mix: basic chemicals and plastics account for 41% of sales; industrial specialties, 26%; and consumer specialties, 32%".

The consumer specialties sector is where most of the profit is derived. Although Dow is the sixth largest chemical company in the world, it aims to take on many of the characteristics and the flexibility of a small company. It is praised for its "superior vertical integration". Dow has not neglected modern technology. "They have now the Insite metallocene based catalyst technology, changing the way of polyolefin production, they built new capacity for superabsorbent polymer and new separation systems based on membranes.

Dow's consumer specialties segment is composed of three businesses: agricultural products, pharmaceuticals and consumer products. The first two are self-explanatory. The consumer products include: bathroom cleaner, Fantastik cleaner, Wrap plastic films, laundry detergents, plastic bags, apple pectin, hair care products. Not everything goes well in this segment: the pharmaceuticals company Marion Merrel Dow has profit problems and spoils the performance of the mother company.

Dow was one of the most cited cases of restructuring. Bower (8) writes: "Until very recently Dow's strategy might be crudely summarized as follows: to be the world's largest

and most profitable producer of commodity chemicals and plastics based on low-cost, using leadership and aggressive marketing in the businesses where it competed. Low costs, in turn, were achieved by vertical integration, technical excellence, near or maximum scale, and leveraged financing. When oil prices skyrocketed, Dow sought integration further back to reduce cost. ...It was ready and willing to use debt to fund a program of backward integration into oil and gas. But the high interest rates and declining real energy prices of the eighties that precipitously altered the attractiveness of Dow's portfolio. They had to scramble to generate funds to eliminate debts, liquidating some of the investments. Resources freed by these measures were used to reduce debt and increase the investment in agricultural chemicals, pharmaceuticals and specialties". The managers of Dow stated: "We were back integrated. But today, you only make your profit at the forward end. You can't afford to back integrate".

The profit situation of the company is curious (Figure 6). During the short improvement of the chemical industry, around the year 1988, the net earnings of Dow improved dramatically, and reached almost 15%. However, in 1992 they dropped to around 2%, like the other leaders. (This may be due to a one time change in accounting practice).

3.2.2.3 Great Lakes

This company can serve as an example of a non-pharmaceutical company, that shows an unusually high profit margin (Figure 6).

From a study of the performance of this company (26,27,28) the following picture is derived: Since 1989 the sales growth averaged 24.3% per year and the net income has also increased by 24.3%. The chairman, E. Kampen, believes that the company can continue to grow at this rate, because of its entrepreneurial culture and its proficiency at managing changes. At any given point of time, 50% of its businesses are undergoing change.

The company has three basic product lines: bromine, furfural and gasoline additives, and each line is integrated from basic raw material to final products, up to consumer goods. Recently great Lakes has acquired Word Blenkinsop from Shell, thus becoming basic also in phosgene products. In general, all its growth has been through acquisitions, made possible by its outstanding cash flow, which distinguishes Great Lakes from other

specialties companies.

Great Lakes spending on R&D is rather low. It was 4.5% on sales in 1988, but dropped to 2.8% in 1991. The healthy cash flow alone cannot explain the high profit rate. Even after deducting the equivalent of the interest rate - the profit stays higher than average.

3.3 Germany

Germany is the cradle of the modern chemical industry, and with annual sales of $MMM 100 is still the largest one in Europe, and number worldwide. Its three leading chemical companies, BASF, Hoechst, and Bayer are numbers 1,2 and 4 in global top 50 chemical companies, after the drop of ICI from the No 1 to the No 3 position, after its split.

The German chemical industry suffers from the same problems, as the other chemical industries in Western countries: low, occasionally negative growth, low profits, and deteriorating trade balance. It has additional problems arising from the unification with East Germany. The chemical output of East Germany is only about 3% of the combined output, but its productivity is low, and the renewal investment is very high (29).

Additional problems of the German chemical industry are: very high environmental spending- 1.6% of the GNP, and high cost of electricity, $0.09/ kWh (4). Still, the general feeling in the industry is that the situation is under control, and that no special measures have to be undertaken. This may be the result of the unusually high added value of the industry (56% of the total shipments value).

The performance of the three largest German chemical companies is shown in Table 12:

TABLE 12

The performance of the largest German chemical companies (11,32)

Company	Sales 1991 $MMM	Sales 1992 $MMM	Net profit 1992 $MMM	Capital spending % of sales	R&D % of sales
Hoechst	30.247	29.403	2.6	8.24	6.3
BASF	29.888	28.540	1.4	9.3	4.6
Bayer	27.180	26.407	3.7	6.9	7.5

The growth rate is negative. The profits are low, but positive, probably due to the high weight of pharmaceuticals among the products. Spending on R&D is higher than for the US companies.

The next three largest companies, Henkel (No. 22 in world ranking) Degussa (No 47) and Huels have only a third or less of the turnover of the first three. Their performance is similar.

3.4 **Great Britain**

ICI is the only one chemical company in UK in the over $MMM 10 class. Despite several attempts of restructuring in recent years ICI found itself in very difficult situation. Its total sales fell from $MM 22,802 in 1990 to $MM 21,309 in 1992. In 1992, for the first time in recent years, it had a net loss of $MM 500. The reaction of the board was swift and unexpected. The board decided on an immediate demerger, in the form of a split between the heavy basic chemicals and the biotechnology, health care and agricultural chemicals businesses. The last businesses representing more than 1/3 of the turnover, were given the name of Zeneca. Each part will be free to develop its own culture and strategy. ICI intended to invest more heavily in its cash cow part, and after the split they could more easily attract investors. Denis Henderson, the chairman of ICI and Zeneca, and the initiator of the split says (23) "...size and tradition alone are not enough to ensure survival", and "Cross-subsidization has often gone on too long and too expensively. Demerger has to some extent reduced the comfort factor and I believe the impact of that will ultimately prove

beneficial." This change comes at the expense of vertical integration, and it is still to be seen how what the reaction on the added value will be, and what will be the influence of the split on the R&D expenses (about 6% before the split).

Another trend said to be "invented by Henderson" (22) is the "swap shop" The "nylon for acrylics" swap with DuPont that was conditionally approved in September 1992 and that took place a few month later, and the "polypropylene for acrylics" with BASF that was announced in January 1993. Since acrylics are among the most promising polymers at present (34), these swaps may be advantageous to ICI. Other British companies like BP, Shell and Octel (A subsidiary of Great Lakes) are trying to follow this lead.

On the whole, British industry has, as in the past, showed original thinking in dealing with its situation. It is too early to judge the outcome.

3.5 **France**

An accepted view among the Western economists, is that the private ownership makes industrial companies more efficient and competitive. France, more than other Western countries, took this axiom with some reservations. David Hunter writes (35) "Nationalization in 1981 saved Rhone-Poulenc from bankruptcy or break-up. State control has prevented RP from raising equity by issuing shares, forcing it to resort to inventive but expensive instruments to finance its growth. But state ownership has permitted it to operate with much higher debt than a private company. This had made possible its aggressive acquisitions strategy - spending $MMM 6.8 between 1986 and 1991 to reshape its portfolio toward biosciences and specialties, and build a US presence. All this is going to change with the sale of the state's remaining 43% holding this fall.

France has no ideological policy of nationalization of private industry, but such actions are part of the arsenal of means of governmental influence. This government influence is more pronounced in the R&D policy, where the government sometimes deals directly with technological development in areas which other governments leave to the industry. In many areas, including some belonging or bordering on the chemical domain, the government support of R&D gave a significant boost to the French industry.

In the final score, France has the fastest growing chemical industry in Europe, with a record production index (relative to 1985) of 130.

Table 13 presents performance figures for the two largest chemical companies in France with a joint turnover of about 1/3 of the total national turnover.

TABLE 13

Performance of the two largest French chemical companies (11)

Company	Sales 1991 $MMM	Sales 1992 $MMM	Net profit 1992 %	Capital spending % of sales	R&D % of sales
Rhone-Poulenc	15.844	15.445	2.7	6.9	7.1
Air-Liquide	6.015	5.537	7.6	11.8	1.6

The current growth rate is negative. The profitability and capital spending of Air Liquide are high. The R&D spending of Rhone-Poulenc is high.

3.6 **The Netherlands**

It may be significant that the Netherlands, with its large chemical industry (around $MMM 25, almost completely export oriented) with companies in the top 25 of the world list (Chemicals sales of Shell - $MMM 10.3 (including UK holdings), of AKZO - $MMM 7.7 and of DSM - $MMM 5 in 1992) is found at the bottom of the added value classification (Table 3).

J. Schoenmakers (33), may have an explanation: "The process of restructuring and concentrating on strong product-market combinations was delayed by the economic boom of the 1980s, which temporarily made the process less urgent. At that time enough money could be made even with sub-optimal mix....The Dutch chemical industry has not changed much during the past 20 years. Despite the fact everybody said a move toward high added value was of vital importance, the industry is still 60% commodity chemicals production, as it was in the 1970s. As a result, the Dutch chemical sector is still one-sided compared with the diversity of products in Germany. Ammonia, salt, and basic plastics account for

80% of the total chemical production in the Netherlands.

Currently, the chemical industry in the Netherlands plans a series of moves, based on the above analysis.

3.7 **Switzerland**

Three Swiss companies, Ciba, Sandoz and Roche, with a joint turnover of over $MMM 25 per year, present one of the most powerful concentrations of chemical industries in Europe. Their leading position in pharmaceuticals and dyes is well known, but their involvement in basic organic and inorganic chemicals is also prominent. Switzerland presents probably the best integrated chemical industry in Europe, with most sales at the consumer end of the line.

Therefore, it appears, in sharp contrast to the Netherlands, at the top of the classification by the added value (Table 3). As a result, the profit margins of the Swiss companies are unusually high for the European environment: 10.4% for Sandoz, 6.8% for Ciba and 14.8% for Roche. More significantly, for all these three companies, the profits have risen consistently during the past 3 years (11).

3.8 **Japan**

The legend that the Japanese chemical industry (second largest in the world at $MMM 180) will not be touched by the recession was incorrect. Last year a slow-down started to spread, commencing from the petrochemical industry, exactly as described by Bower (8) a decade earlier. There are no signs yet of recovery, despite the usual heavy involvement by the government, which at this moment is not very effective. It will be interesting to observe, if the proximity and close ties binding Japan with the countries of the Pacific Rim will have a smoothing effect on this recession.

Other factors which may influence the recovery: The Japanese chemical industry is very decentralized, the 12 largest chemical companies do not account even for 1/3 of the total chemical sales, (very unlike the other industrialized countries). The largest company, Asahi

Chemical (No 13 in the worlds top 50 list), has sales under $MMM 8. This may add flexibility to the fight with recession. The government, on its part, has curbed administratively chemical imports, thus attempting to protect the local production (36).

For illustration of the present situation in Japan, Table 14 shows the net sales and profits of 6 leading chemical companies:

TABLE 14

Performance of some Japanese chemical companies (11)

Company	Net Sales 1991 $MMM	Net Sales 1992 $MMM	Net Profit 1992 % of sales
Asahi Chemical	7694	7849	1.7
Mitsubishi Kasei	5740	5602	0.7
Sumitomo Chemical	5554	4926	0.9
Sekisui Chemical	5130	5324	1.5
Toray Industries	4729	4578	4.1
Showa Denko	4552	4015	1.3
Takeda Chemical	4427	4458	5.6

For 4 companies the growth rate was negative (It used to be at least 4% per year). Toray and Takeda produce mainly pharmaceuticals, hence the higher profits. For the other companies the 1992 profits are less than half of the profit in recent years.

3.9 China

In its efforts to change from a communist economy to a more competitive form, China took the diametrically opposite direction of Russia, i.e. by relaxing the centralist rule over the economy before changing the political regime. So far, this formula seems to work better than the Russian formula. Its essence: to delegate the immediate tasks to private, competitive hands, while keeping the long term planning with the central government. The comparison with the former Soviet Union is not completely fair: China has a much larger more population, but since the economy is much smaller, it is easier to manage. The

growth rate of the Chinese chemical industry in 1992 was twice its average rate in the past 5 years (Table 9).

A more detailed picture of the recent growth of the Chinese chemical production is shown in Table 15:

TABLE 15

The growth of Chinese chemical production (in 1000 metric tons)(39)

Product	Thousand tons				%change
	1989	1990	1991	1992	91/92
Ammonia	20675	21251	21973	22965	5
Fertilizers	18547	18790	19783	20990	6
Sulfuric acid	11408	11967	13333	13960	5
Sodium hydroxide	3211	3388	3533	3778	7
Sodium carbonate	2983	3799	3935	4506	14
Plastics	1973	2249	2640	3142	19
Synthetic fibers	1466	1655	1909	2083	9
Detergents	1431	1516	1461	1616	11
Ethylene	1405	1572	1746	1982	14
Pesticides	224	228	255	284	11
Drugs	196	172	195	219	12
Synthetic rubber	289	315	335	366	9

Although the quantities shown in Table 15 are large, the per capita use is still very small.

The ten largest chemical companies in China in 1992 are listed in Table 16:

TABLE 16

The ten largest chemical companies in China in 1992

(An exchange rate of $1 = 5 yuan was assumed)

		$MMM
Shanghai	Petrochemical General	1.7
Beijing Yanshan	Petrochemical	1.5
Jilu	Petrochemical	1.3
Jilin	Chemical Industrial	1.2
Daqing	Petrochemical General	1.2
Wushun	Petrochemical	1.2
Maoming	Petrochemical	1.1
Jinling	Petrochemical	1.0
Shanghai Gaoquiao	Petrochemical	1.0
Yangzhi	Petrochemical	0.9

Almost all companies in this list are named as petrochemical companies. The majority of companies with typically chemical names can be found much lower on the list, with annual sales reaching $MM 300 or less. The total output of the Chinese chemical industry was reported for the year 1992 to be $MMM 43.6, 10% higher than in the previous year.

The growth rate of the Chinese chemical industry appears to be limited only by the buying power of the population of the country (and to some extent on the success of exports. Currently the balance of the chemical trade is a negative $MMM 5). The possibility of its reversal is not clear. The Chinese Minister of chemicals, Mrs. Gu Xiulian complained that the first half of 1993 showed only 6.7% growth (over the matching period last year) because of the cuts in government subsidies to agricultural chemicals (42).

A forecast by Shahid Burki, director of the World Bank's China Department: "The World Bank predicts an 8.5% annual increase in China's GDP for 1992-2000, taking the GNP from $MMM 370 in 1991 to $MMM 730 in 2000. The income per capita will rise from $370 in 1991 to $560 in 2000 in real terms. Under such a scenario, China will still be a poor country. Estimates saying that the income per capita will reach $4000 are dismissed by the bank." On this basis the 10% growth target set by the government for the chemical industry is possible, following the 1992 rate of growth.

In a few of China's regions, that are autonomous to some extent, for example: Guandong, Fujian, Jiangsu and Shandong, called the "Inner Dragons" the development is even faster. The chemical industry there is expected to grow at a spectacular rate.

The two economic problems of China are: to build the markets for future expansion, and to obtain funds for investments. This second problem is not so acute, since many among the "Chinese Diaspora" developed "China fever". According to the Ministry for Foreign Trade and Economic Relations ("Moftec"), of the $MMM 37 in foreign investment in 1979 - 1992, $MMM 21 came from Hong Kong and Macao and further $MMM 2 came from Taiwan. This investment stream is widening each year. Chemical companies from all over the world are investing in China. Hoechst has investment projects in China for over $MM 400 in 5 years.

The ratio of added value to the chemical output value is 35% (Table 3). This may be a consequence of good integration of the industry, starting from basic petrochemicals and, perhaps, lack of foreign currency for imported raw materials.

The per-capita added value in China is under $100, (Compared to over $5000 in the USA, and about $1800 p.a. in Israel). Since even at that national efficiency the Chinese chemical industry is among the first ten in the world - it is clear that it will have an impact on the world chemicals market.

3.10 **South Korea**

South Korea was chosen here as the main representative of the "Little Dragons". The original "little Dragons", one of the most interesting phenomena of contemporary economics, included South Korea, Taiwan, Hong Kong and Singapore. In the last decade their economy, including the chemical industry, has shown a continuous boom. It started, by high productivity, caused partially by low wages. This attracted foreign industry, which erected local daughter production companies. As a result, foreign technology was imported, foreign loans helped to erect industrial infrastructure and local specialists acquired high technical skills.

With the rising local income, the market developed quickly and induced further development. This reasoning, while plausible, does not explain why such development did not take place at many other countries. Possibly, the Japanese influence was a factor, not always in Japan's favor. J. Greenwald is quoted in Time (37): "According to Sanwa Research Institute, Japan stands to lose 1.3 million jobs by the end of the decade if companies continue to accelerate the rate at which they build foreign factories.

Currently, new "Little Dragons" are appearing: Malaysia, Indonesia, and Thailand. Even Vietnam is mentioned as a new economical miracle of the Far East.

The development rate of the chemical industry in South Korea resembles those of West Europe in the sixties, and is better than the overall (and impressive) figures for all the South Korean industry as can be seen in Table 17:

TABLE 17

The Korean industrial trends Production index

(1985=100) (11)

	1989	1990	1991	1992	% change 92/91
All Manufacturing	171.3	186.5	202.6	212.3	5
Chemicals & allied products	154.8	172.9	194.2	218.2	12
Industrial chemicals	156.6	188.6	222.9	271.1	22

The highest growth rate, over 70%, was in ethylene, propylene, benzene and butadiene.

4. THE ISRAELI CHEMICAL INDUSTRY

4.1. Scope of the information

Most of the sources of information about the Israeli chemical industry were created either in order to interest buyers and investors (38,39,40) - or as part of general statistical information, covering all segments of the industry (41,42,43), and are occasionally inaccurate.

The behavior of the chemical industry in Israel changed with the passage of time. The most pronounced characteristic being the rate of growth, but other changes include the attitude towards investments, R&D, and long-term development.

There is no available organized information describing the development of the Israeli chemical industry over the years and presenting the changes and unusual occurrences as they took place. Such information is required in order to observe and analyze trends, and this information has to be collected from various sources inside and outside the industry.

We have used the available information about the Israeli industry and the chemical segment of the Israeli industry. We have collected information about individual companies, whenever available, and collected data about turnover (over 5 years, if possible), exports, the line of products, from which the market distribution could be estimated. We could not get adequate data about investment, and information about profits was available only for public companies. No effort was made to quantify R&D efforts. The integrated results reported by the companies were compared with the overall data for the chemical industry published by official agencies.

In addition to the collection and analysis of data, two original contributions are presented:
1. The comparison of the added value of the Israeli chemical industry with other countries which were presented in Tables 2 and 3.
2. The local and export markets distribution of the products of the Israeli chemical industry presented in Tables 28 and 29.

In the past few years and especially last year, the growth rate of the industry went up. The trend appears to be real, but somewhat exaggerated due to the inclusion of petroleum distillation products in the statistics of chemical products.

4.2 **Historical Background**

The chemical industry in Israel is relatively young. A few tiny consumer oriented production facilities were built in the twenties, and a small potash plant that was destroyed in the war of independence was built at the Dead Sea in the thirties. However, the first facility that can be called a chemical plant was the fertilizers plant at Haifa that was built after the Second World War. (The Haifa refineries were built during the war, but at that time included almost exclusively distillation units). Comparably, the European chemical industry, is at least 3 times as old.

The Israeli chemical industry started in 4 separate centers, which still exist as more or less separate entities:

1. The Oil Refineries, erected by the British to help in the war effort, and later formed the basis for the petrochemical industry. They also started the Haifa Chemicals, which was later privatized.
2. Fertilizers and Chemicals, Dead Sea Works and Negev Phosphates, producers of fertilizers.
3. Makhteshim and Agan, the leaders in the synthetic pesticides for decades.
4. Pharmaceuticals which started in several locations, but were dominated by Teva, which acquired most of the early pharmaceutical companies.

The first two groups were started by the government. The third group was part of the Union industries and only the fourth group was developed by the private sector.

Bordering the chemical industry was the development of the food processing industry (mainly citrus and oil), and consumer oriented production plants for paints, lacquers, soap, etc.

The output of the 4 main centers has grown steadily and their orientation has changed from supplying the local markets only, to exports.

Mergers and other conglomerations (such as the Teva - Abic, Makhteshim - Agan, Negev Phosphates - Rotem Fertilizers mergers) were usually within the same market orientation and did not lead to the development of multidisciplinary corporations typical of the chemical industry in the world.

The largest chemical corporation, Israel Chemicals, is the closest to a multidisciplinary concern but is still dominated by the mineral raw materials it uses and the agricultural market.

This structure can partly explain why several product lines, important in the world, are missing in the existing organizational grid, and why there is limited vertical integration, and hence low added value to the national economy.

Two other characteristic features of the chemical industry in Israel:

1. It was difficult to buy know-how licenses from foreign companies,partly due to the small internal market, and partly due to the Arab boycott. This was particularly pronounced in the pharmaceutical and pesticides industry, and encouraged the development of production processes for me - too products, and prevented the erection of large plants, which could have offered the economy of scale. It also made the training of the professional personnel difficult.

2. As the industry became export oriented its market development depended on sophisticated local customers for technical feedback. These customers were mainly from the agricultural market. This directed the development of the industry into the cycle prone, low growth, and often depressed agriculture export market.

Another reason for the domination of the agriculture market was the abundance of some raw materials for this market: potash, phosphate, (and also bromine and magnesium salts), and their exploitation was seen as a national priority.

Pesticides were needed for modern agriculture, and their local production was also favored, in order to conserve scarce foreign currency. The production was supported by a system of grants and low interest loans. This support was higher if the project was erected in a location far from the center of the country , which gave an additional boost to locating most the new chemical plants in the Negev.

To some extent the rate of growth of industry was more a function of the financial policy of the current government than of market demand. For instance, the plants built during the onset of the high inflation (in the seventies) received unlinked loans, which were practically grants.

This policy encouraged the fast growth of the chemical industry, and founded a base for future development. There were some inevitable failures, the most prominent of which was the first Arad plant for HCl from magnesium chloride brines using fluidized bed technology. This policy and a liberal support for research in industry favored a few important technological developments, such as the cold process for potash, the extraction process for high quality phosphoric acid, the Aman process for periclase, the potassium nitrate extraction process and several new processes in the organic pesticides industry. It is not certain that those successful processes would have been implemented if judged only on the basis of an analysis of short-term financial feasibility.

As the chemical industry matured such breakthroughs became increasingly rare, and the growth rate of the industry slowed.

4.3 Salient Statistics

In most classifications of the chemical industry in the world, the production of fertilizers, is considered as part of the chemical industry. In Israel, for some historical reasons, the production of potash and phosphate rock is listed as "mining and quarrying", under code 10. We took care to include them in our salient statistics. We have also used this separation of classifications in Tables 18 to 21, which give overall data for the chemical production and industrial production in Israel.

TABLE 18

Yearly and average real change of production

of the Israeli chemical industry, % (41)

	1988	1989	1990	1991	1992	79-85	85-92	79-92
chemicals	1.0	1.0	4.9	4.2	10.4	2.3	4.8	3.7
mining	-1.6	2.7	5.9	8.6	6.3	2.6	5.4	4.1
total	0.5	1.4	5.1	5.1	9.5	2.4	4.9	3.8

The data in Tables 18 - 21 were not adjusted for distillates. When comparing with foreign data, it was necessary to adjust the numbers by deducting the distillates, which are not considered chemical products in world statistics.

The bias caused by the distillates was greater in the seventies, although unlike last year, this bias acted then in the direction of reducing the real growth rates. In 1975 the distillates represented 63% of the total value of chemicals (without mining), and in 1976 - 62%. The reported real growth rate (adjusted only for inflation) for chemicals in 1975 - 1976 was 4.4%, and in 1976 - 1977 it was 5.1%. (46). After adjusting for the distillates, the adjusted real growth rate was 8% and 9% respectively. In the sixties the adjusted real growth rate of the chemical industry was over 10%.

TABLE 19

The share of chemicals in total Israeli industrial sales, % (41)

	1970	1975	1980	1992
Chemicals	6.6	8.2	9.4	10.8
Mining	2.3	2.6	2.8	1.9
Chemicals and mining	8.9	10.8	12.2	12.7
Industry without diamonds	10	12	14	14

The diamond industry with its low added value distorts the total industry figures. Therefore, the last line shows the share of the chemical industry to the total industry, adjusted for diamonds.

The share of electronics in the total industrial sales rose during those years from 6.4% to 14.5% and has passed the chemical industry. The share of metal products rose from 8.9% to 9.1%.

The total exports of chemicals + mining in current dollars were :

$MM 1454.5 + 300 in 1991 and $MM 1542.2 + 303.6 in 1992 (41).

TABLE 20

Annual and average change of exports of the Israeli chemical industry:

(in real terms), % (41)

	1988	1989	1990	1991	1992	79-85	85-92	79-92
Chemicals	4.6	6.6	5.3	2.8	8.9	2.6	8.4	5.9
Mining	-10.7	-0.5	-4.2	-4.1	-4.1	2.6	-3.3	-0.4
Total	1.4	5.1	3.3	1.3	6.3	2.6	5.9	4.6

The sharp change in 1992 caused by a jump in exports of oil distillates after the reform of the oil industry in Israel.

For the first 11 months of 1983, the total exports grew over the similar period last year by 16.4% and without diamonds by 17.5%. The chemicals exports grew by 18%, and mining exports were reduced by 7%. The highest increase was in pharmaceuticals, due to the registration of many new generic medicines.

TABLE 21

The share of chemicals in total Israeli industrial exports, % (41)

	1970	1975	1980	1992
Chemicals	10.2	12.3	15.2	13.5
Mining	7.0	5.6	3.3	2.4
Total chemical industry	17.2	17.9	18.5	15.9
Without diamonds	26.1	28.1	26.3	20.6

The export share of mining has been steadily dropping. Chemicals also suffered from the European market slump in 1992, and with adjustment for distillates their export share would show even a drop in 1992. The best performing industry in recent years was the electronics industry. The share of electronics in total exports rose over those years from 3.2% to 26.1%, and the share of metal products rose from 5.6% to 6.9%.

The gross investment in the chemicals industry was in current NIS 976 millions in 1991 and 1423 millions in 1992, a real growth of 33.1%. (Inflation was around 12%). The investments in mining were 571.9 millions in 1991 and 538.7 millions in 1992, a real decline of 14.2%. The average real growth of investments over the years 1979 -1992 was 10.7% for chemicals, and 1.2% for mining. The share of chemical investments in the total investments in the industry was fairly stable over the period of 1970 - 1992, ranging from 22.9% in 1970, to 26.9% in the 1992. The sales expenses in 1992 amounted to 13% of sales.

The R&D spending of the Israeli chemical industry was low and averaged only 1.5% of sales, about 1/3 of the rates of the Western countries.(41)

4.4 Main Products

The rate of the development of the chemical industry in Israel is shown in Table 22 by an overview of the quantities produced from 1970 to 1992.

TABLE 22

Production of the main Israeli chemical commodities (tons)(42)

Product	Units	1970	1980	1990	1991	1992
Potash	1000 t	869	1343	2124	1958	2086
Phosphate rock	1000 t		2307	2472	2267	2372
Ammonia	t	37745	66702	77582	55056	41072
Amm. sulphate	t	67824	38231	35441	14875	12444
Dicalc. phosph.	t	13516	16466	20820	24738	20515
Sulphuric acid	1000 t	203	209	154	136	138
Chlorine	t	14833	35310	36342	36105	33912
Caustic soda	t	15923	35268	31575	32180	29459
Polyethylene	t	17765	60997	106599	124613	128739
Paints	t	19488	26953	46341	48242	58242

Other important bulk products (1988 figures): Organic solvents - 160000 tons, Polystyrene - 11000 tons, PVC - 80000 tons, MTBE - 12500 toms, Methanol - 40000 tons (45), Pesticides - 100000 tons (44).

4.5 Major Companies

We have picked 50 chemical companies in Israel. The criteria for picking a company was a turnover in 1991 of over $MM 50. However, we have added a few biotechnology companies with lower turnover. This list of companies includes those engaged in "mining products" and "fuels" (the last represent at least 85% of the output of the Oil Refineries). The list also includes nylon fibers produced by Nilit.

We have also added Israel Chemicals (controlling Fertilizers and Chemicals, Dead Sea Works, Amfert-Rotem-Phosphates (a recent merger) Periclase, Negev Ceramics, Rami Ceramics, Timna Copper Mines, the bromine companies, and a number of companies abroad).

The data gathered for the individual companies are taken from several sources, the most important of which is Dun's Guide (38) which uses figures reported by the producers, which may occasionally be biased on the higher side.

Comparing some of our figures with a study performed in 1992 (3) that covered 124 chemical companies, has shown that our list of companies represented 97% of the chemical sales, and 99% of the chemical exports of the Israeli industry.

We have avoided double summation by excluding Israel Chemicals from the totals, since its Israeli daughter companies were listed separately. Abic is now part of The Teva group, and Bromine compounds is part of the Bromine group.

Table 23 presents the turnover of the larger chemical companies in the past 5 years.

TABLE 23
Turnover of the largest Israeli chemical companies
(in current $M) (38)

	1988	1989	1990	1991	1992
Biotech General	2286	7000	1216	1621	2318
Rekah		2000	2000	2300	2300
Rad Chemicals	2200	2100	2310	2500	2500
Biological Ind.	6310	5985	4946	4167	6310
Orgenics	1300	4000	4500	2200	2860
Chemada	4500	5000	5800	5900	6300
Chemagis		2650	6400	6500	7000
Maxima	7040	6987	7000	7000	9000
Deshen Gat	2700	8000	7700	8200	8200
Taro	5900	6201	7656	9142	10981
Makor	7300	7300	6800	9209	7000
Serafon	4000	5175	6348	9277	13000
Vitamed	6000	6429	7910	9649	10000
B.G. Polymers	5000	4797	6104	10254	9000
Pazchem	18000	16300	16000	11475	15000
Rafa			8500	12000	12000
Fisher		10000	12000	12000	12000
Nir Lat	4200	4700	5500	12000	12000
Explosives	7000	5440	8000	14500	14500
Kedem	9600	9325	13000	13000	16000
Pazkar		10037	12642	15464	25000
Dor Chemicals	16000	16000	16000	17500	17500
Trima		19800	17587	17587	21000
Frutarom	12000	13000	14000	15000	18200
Sharon Labs	18000	18000	20500	20000	17000
Luxembourg	10700	17348	15500	18000	18000
Dexxon	9800	12930	15850	19000	25000
Neca	14639	15595	18500	23000	27000
Carmel Chem.	22000	21000	19531	25000	25000
Avco	14500	16000	21000	32000	33000
Zohar Dalia	25881	27600	31360	32200	32000
Interpharm	18000	13772	25200	35196	51600
Sano Bruno's	33026	33881	39021	38298	38000
Periclase	29210	32893	40421	39242	42800
Koffolk	28934	30531	33539	40702	45000
C.T.S.	2800	4946	5000	6000	7200
Abic		49879	56500	58200	68000
Nilit	79471	86612	83418	85012	85000
Fert. & Chem	89500	94319	104085	91971	97900
Gadot	75089	88306	83556	92705	101600
Carmel Olefins	122000	101132	128400	108161	120000
Tambour	90500	92549	94804	108755	120000
Electrochemical	105164	117849	120707	116521	120000
Agan	89027	93579	111202	122996	131500
Makhteshim	136600	157351	172041	172041	178000
Haifa Chemicals	132500	145000	155300	177500	200000
Amfert Phosph.	313000	396935	402000	396700	317000

	1988	1989	1990	1991	1992
Bromine Comp.	273299	297800	313501	332000	328000
Teva	211092	268500	295200	320983	396336
Dead Sea Wks	508104	544662	566755	558410	580100
Oil Refineries	375000	615000	797000	827000	933000
Total	2675873	3224516	3499809	3735838	4002005
Israel Chemicals	965806	1010418	1067923	1054685	1065054

After deflation to the constant 1988 dollars, the yearly growth rate is calculated and presented in Table 24.

TABLE 24

Adjustment of the totals in Table 23

to 1988 constant $

	1988	1989	1990	1991	1992
Current $M total	2675873	3224516	3499809	3735838	4002005
Deflator	1	1.06	1.06	1.08	1.08
Deflated total	2675873	3041996	3301706	3459109	3705560
Real growth %		14.0	9.0	5.0	7.0
Growth adjusted for fuel		15.0	3.0	7.0	5.0
Reported growth		1.4	5.1	5.1	9.5

Table 25 presents chemical exports of the same companies. The last column indicates if the overall change of the export by the company was positive or negative.

The MA classification of companies is used by the Manufacturers Association of Israel: 1- Mining and quarrying, 2- Petrochemical, 3- Paints, 4- Food additives, 5- Biotechnology, 6- Fuels, 7- Cosmetics, 8- Pesticides, 9- General chemistry, 10- Pharmaceuticals, 11- Intermediates, 12- Fertilizers, 13- Detergents, 14- Medical equipment, 20- Not classified elsewhere.

TABLE 25

The export by Israeli chemical companies (38)

Company	Exports in $M 1990	1991	1992	MA Classific.	Gain
Biot General	1034			5	
Rekah				5	
Rad Chemicals	2000	2000		5	
Biological Ind.	3165	1458		5	
Orgenics				5	
Chemada	4250	4250	5500	11	+
Chemagis	5900	6200	6100	11	+
Maxima					
Deshen Gat					
Taro					
Makor	6500	8628	8900	5	+
Serafon					
Vitamed					
B.G. Polymers					
Pazchem	5000	2832	2800	8	-
Rafa					
Fisher	500	2000	2800	10	+
Nir Lat	2000	3000	3000	9	+
Explosives					
Kedem					
Pazkar					
Dor Chemicals		3500	1176	11	-
Trima					
Frutarom					
Sharon Labs	5000	2832	2800	4	-
Luxembourg	11000	14000	14300	8	+
Dexxon					
Neca					
Carmel Chem.		22500	12013	11	-
Avco	4500	9600	10000	13	+
Zohar Dalia	3120	3000	3157	13	
Interpharm		33500	38000	5	+
Sano Bruno's	500	765		8	
Periclase	34298	37279	32405	11	-
Koffolk	21128	22900	22600	11	+
C.T.S.				10	
Abic	15600	17100		10	+
Nilit	82301	84091	85000	20	+
Fert.& Chem.	31166	32592	30955	12	-
Gadot	67736	76573	84100	2	+
Carmel Olefins	52000	39000	36797	2	-
Tambour	6588	8000	7000	3	
Electrochemal	67840	60750	58300	2	-
Agan	92490	118995	115100	8	+

Company	Exports in $M 1990	1991	1992	MA Classific.	Gain
Makhteshim	137700	130100	138600	8	
Haifa Chem	125500	147000	166200	12	+
Rotem-Amfert	81934	95400	169400	12	+
Bromine Comp	213400	318140	329000	11,8	+
Teva	136000	151036	150000	10	+
Dead Sea Wks	496780	496900	563000	10,12	+
Oil Refineries	191000	230000	239000	6	+
Total	1677896	1851715	2009003		
Israel Chemicals	629000	628192	642896		

Several figures were not cross checked and appear to err on the high side. There is an inconsistency in the figures concerning Israel Chemicals due to the inclusion of its foreign operations in its totals. The negative gains were mainly in polymers. Table 26 was generated by the same procedure as Table 24:

TABLE 26

Adjustment of the totals in Table 25 to 1988 constant $

		1990	1991	1992
Total exports	in $1000	1677896	1851715	2009003
Deflator		1.06	1.08	1.08
Total in Constant	$1000	1582921	1714552	1860188
Real growth			8	8
Reported growth			1.3	6.3

These figures were not adjusted for distillates.

4.6 **Production segments**

The development of different segments of the chemical industry in Israel occurred at different rates, and did not follow the pattern of other countries. This can be seen by comparing the production indices by segments for Israel (Figure 7) and for the US (Figure 8).

The growth of the chemical industry, as well as its main segments, was faster in Israel than in the US in particular in the pesticides and the drugs segments.

We have consistent data starting only from 1979, when the very fast development of the pesticides companies has already reached its zenith and the development of pharmaceuticals has just begun. Pharmaceuticals were the leaders from 1979 to 1992. Basic chemicals, have grown fast from 1982 to 1987, with modest growth rates in other periods. The basic chemicals category is a strange mix of industrial chemicals, fertilizers, monomers, pesticides and intermediates. Changes in capacities of fertilizers on one hand, and of monomers on the other hand influenced the performance of the basic chemicals. The growth index of pesticides changed little during the covered period Using the official classification of segments, the exports by segment are presented in Table 27:

TABLE 27

Export by segments of the chemical industry in Israel in constant 1988 $MM (41)

Segment	1970	1980	1988	1989	1990	1991	1992
Evaporated salts	52	104	166	173	176	162	157
Other minerals	29	33	77	78	66	68	67
Basic chemicals	58	365	750	847	884	915	913
Drugs	23	42	94	62	81	106	156
Pesticides	32	125	115	44	37	33	36
Distillates	106	89	202	217	224	215	264
Total	300	758	1404	1421	1464	1502	1557

FIGURE 7: The production of the Israeli chemical industry by segments.

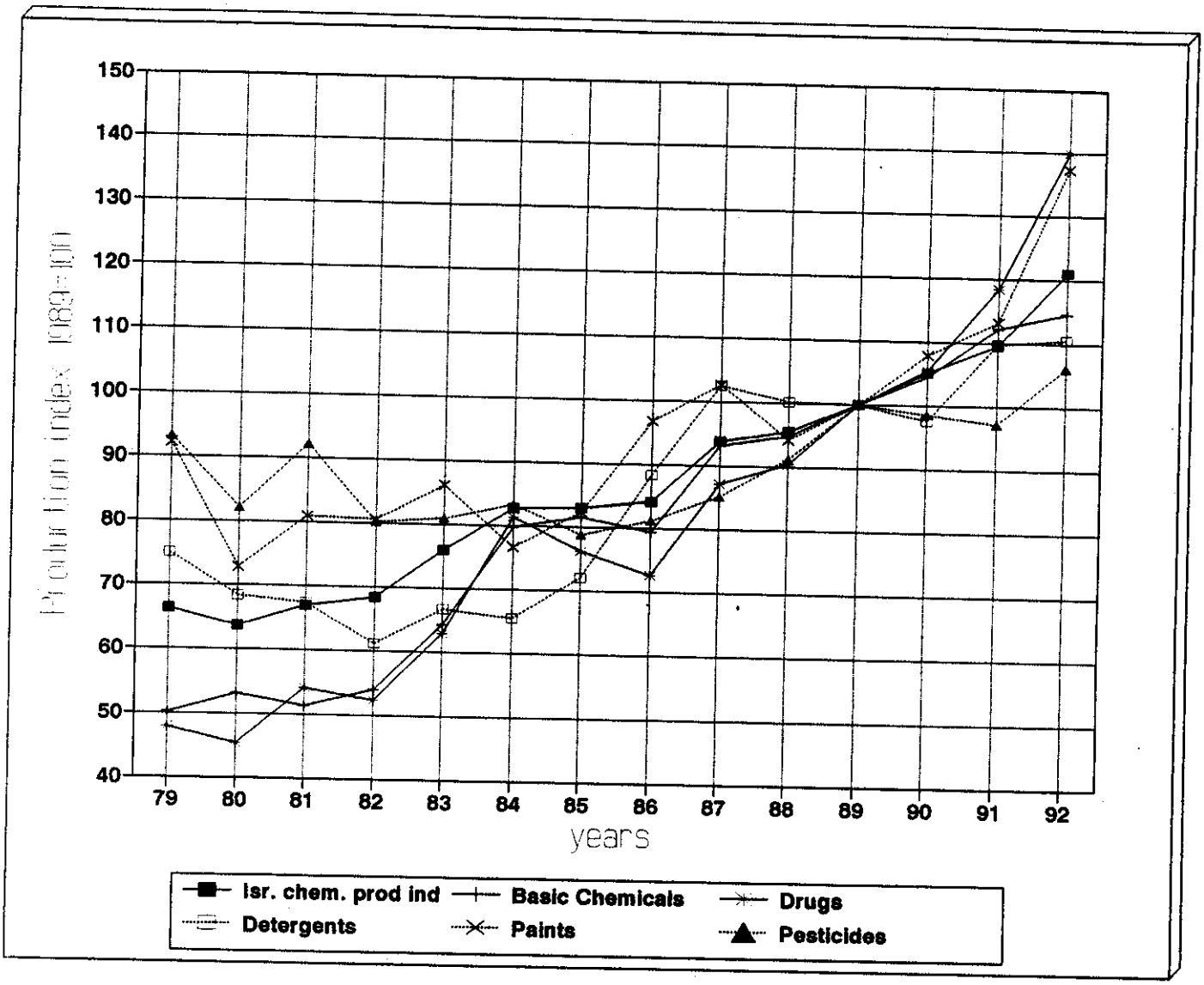
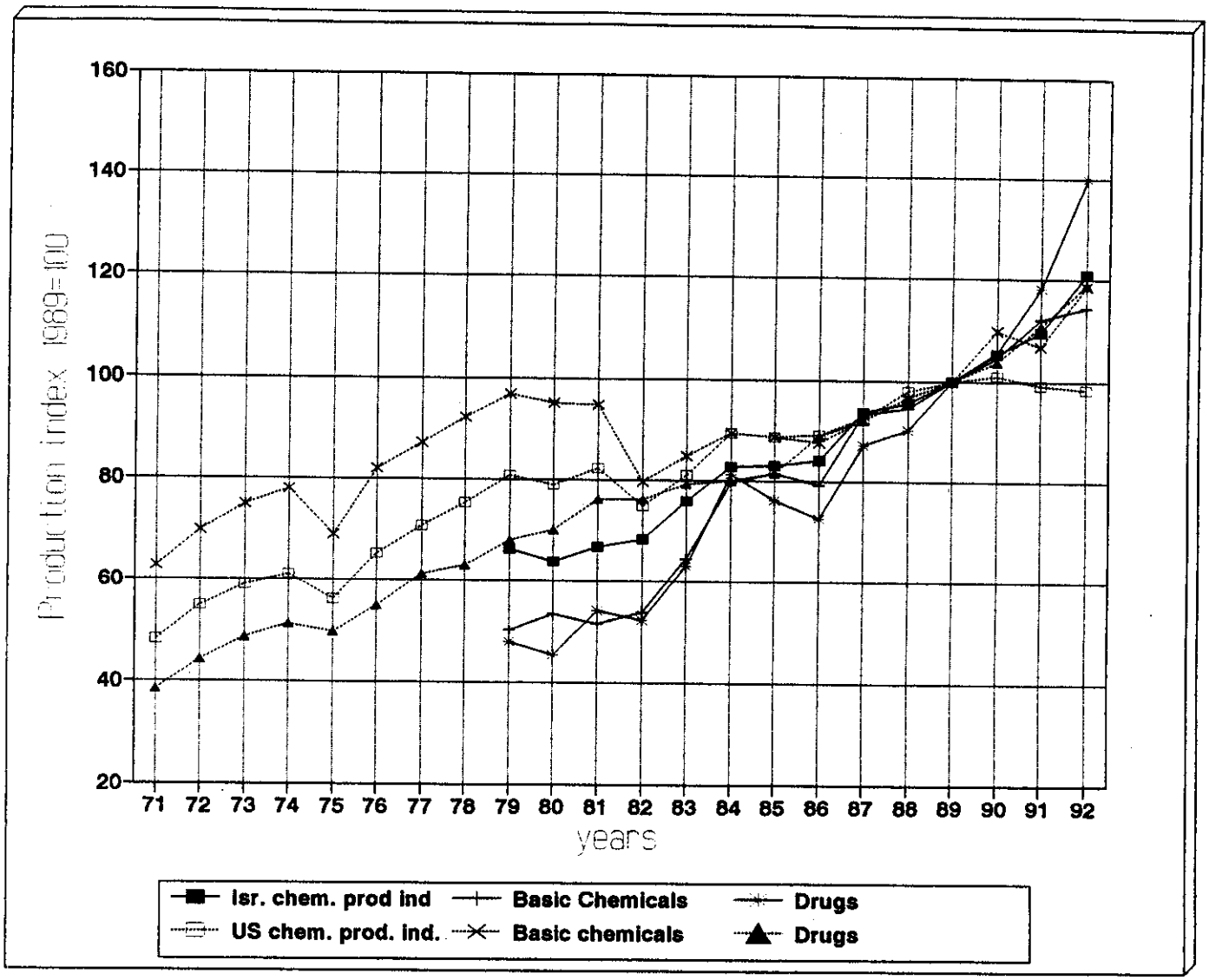


FIGURE 8: Comparison of the US and the Israeli chemical industries.



Note the abrupt change in the export of distillates in 1988, and in 1992. A change in the official classification transferred the major part of the pesticides in 1989 to basic chemicals (probably except formulations). The official definition of basic chemicals presents too wide a category to be of any practical use. It currently includes industrial chemicals, monomers, fertilizers, intermediates and pesticides.

4.7 Target markets

More useful information can be extracted from the data, when we arrange the local sales of the main chemical companies according to target markets.

TABLE 28
Local sales distribution of Israeli chemical Companies
by target markets (1992)(in $MM) (44)

	drugs	indus trial	buil ding	agricu lture	house hold	food	plas tics	text ile	ener gy
Biotechnology General	2								
Rekah	2								
Rad Chemicals	3								
Biological Industries	6								
Orgenics	3								
Chemada		1							
Chemagis	1								
Maxima		9							
Deshen Gat				8					
Taro	11								
Makor									
Serafon					13				
Vitamed	10								
B.G. Polymers			9						
Pazchem				12					
Rafa	12								
Fisher	9								
Nir Lat			9						
Explosives			15						
Kedem					16				
Pazkar			25						
Dor Chemicals		16							
Trima	21								
Frutarom						10			
Sharon Labs						14			
Luxembourg				4					
Dexxon	25								
Neca				27					
Carmel Chemicals							13		
Avco								23	

	drugs	indus trial	buil ding	agricu lture	house hold	food	plas tics	text ile	ener gy
Zohar Dalia					29				
Interpharm					38				
Sano Bruno's									
Dead Sea Periclase		10							
Koffolk		22							
C.T.S.				3	4				
Abic									
Nilit									
Fertilizers & Chem.		7		60					
Gadot Petrochemical		7				5	6		
Carmel Olefins							83		
Tambour			128						
Electrochemical Ind.		9			1	2	50		
Agan				16					
Makhteshim		4		30	2		3		
Haifa Chemicals		17		17					
Rotem-Amfert		48		100					
Bromine Compounds									
Teva	246								
Dead Sea Works		7		10					
Oil Refineries		120							574
Total	351	285	186	260	129	34	140	28	574
% of 1987	18	14	10	13	6	2	7	1	29

Oil refining that amounts to about 30% of the total sales is in its special target market here. The weight of intermediates (i.e. products sold to the chemical industry for further processing) is exceptional low, and probably accounts for the low added value of the Israeli chemical industry.

A similar separation by target export markets is shown in Table 29:

TABLE 29

Distribution of Israeli chemical exports

by target markets(1992)(in $MM)(44)

	drugs	indus trial	buil ding	agricu lture	house hold	food	plas tics	text ile	ener gy
Biotechnology General									
Rekah									
Rad Chemicals									
Biological Industries									
Orgenics									
Chemada		6							
Chemagis		6							
Maxima									
Deshen Gat									
Taro									
Makor		9							
Serafon									
Vitamed									
B.G. Polymers									
Pazchem				3					
Rafa									
Fisher				3					
Nir Lat			3						
Explosives									
Kedem									
Pazkar									
Dor Chemicals		1							
Trima									
Frutarom						8			
Sharon Labs						3			
Luxembourg				14					
Dexxon									
Neca									
Carmel Chemicals							12		
Avco								10	
Zohar Dalia					3				
Interpharm	38								
Sano Bruno's									
Dead Sea Periclase		32							
Koffolk		23							
C.T.S.									
Abic									
Nilit									
Fertilizers & Chem.				31					
Gadot Petrochemical		44				20	20		
Carmel Olefins							37		
Tambour			7						
Electrochemical Ind.							58		
Agan				115					

	drugs	indus trial	buil ding	agricu lture	house hold	food	plas tics	text ile	ener gy
Makhteshim				139					
Haifa Chemicals		33		133					
Rotem-Amfert				169					
Bromine Compounds		150		150				29	
Teva	150								
Dead Sea Works				234					
Oil Refineries									239
Total (2017)	188	304	10	991	3	31	156	95	239
% of total	9	15	1	49	0	2	7	5	12

The agriculture markets dominate and comprise of 49% of the exports when the distillates are included in the total. Without the distillates, the agriculture markets account for 56% of the total exports.

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