THE SHIFT FROM U.S. PRODUCTION OF COMMODITY PETROCHEMICALS TO VALUE-ADDED SPECIALTY CHEMICAL PRODUCTS AND THE POSSIBLE IMPACT ON U.S. TRADE

Report on Investigation No. 332-183 Under Section 332(b) of the Tariff Act of 1930

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PREFACE

On April 5, 1984, the United States International Trade Commission, in accordance with the provisions of section 332(b) of the Tariff Act of 1930 (19 U.S.C. 1332(b)), instituted investigation No. 332-183 on its own motion for the purpose of assessing the shift from U.S. production of commodity petrochemicals to value-added chemical products and the possible impact on U.S. trade. Notice of the investigation was published in the April 18, 1984 issue of the Federal Register (49 F.R. 15286). Information for this report was obtained from Commission fieldwork, industry submissions and publications, the Commission files, other Government agencies, and other sources. This report assembles and presents, in a readily usable form, information and data, from diverse sources, on the changing competitive position of the United States and other nations in the world petrochemical market.

The U.S. petrochemical industry remains the largest producer of commodity petrochemicals, specialty chemicals, and all other petrochemical industry products. However, developments in certain conventional energy-rich nations could impact the future direction of the U.S. industry and change its strategic goals. Nevertheless, the U.S. industry is expected to retain its inherent commodity petrochemical orientation, and also to develop a strong specialty chemical industry position.

This report presents the findings of the Commission's investigation. It includes analyses of the factors that influence the U.S. petrochemical industry, such as U.S. demand, production, consumption, and trade, as well as information concerning the petrochemical industries of other traditional petrochemical-producing nations. The report also discusses the current status of commodity petrochemical development in conventional energy-rich nations. Using the collected information concerning the changing world petrochemical situation, this report examines and assesses the changes expected to occur in the U.S. petrochemical industry and quantifies the possible future impacts on U.S. industry output and employment using the U.S. Department of Labor's input-output model of the U.S. economy.

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EXECUTIVE SUMMARY

The U.S. petrochemical industry has entered a period of numerous changes, which are expected to have a lasting impact on it's structure and strategic orientation. These changes are related primarily to the two crude petroleum price shocks during the 1970's, which resulted in decreased demand growth rates for commodity petrochemicals, as the worldwide recession and energy conservation tempered demand. Also, the development of state-of-the-art commodity petrochemical production capacity in nations advantaged in terms of both feedstock cost and feedstock availability increased the supply of these materials. This supply/demand imbalance led to declining profitability for commodity petrochemical producers located in the United States, as well as other traditional petrochemical-producing areas of the world during 1979-85.

Petrochemical industry analysts uniformly recommended that certain petrochemical producers, which traditionally have been strategically oriented purely toward production of commodity petrochemicals, alter their strategic outlook and take advantage of the burgeoning demand for specialty chemicals. Commodity petrochemicals, derived principally from crude petroleum-based feedstocks and natural gas-based feedstocks, are the building block petrochemicals for much of the world's chemical products industries. 1/ These commodity petrochemicals are sold primarily on a price basis, and all of the commodity petrochemical production from any of the diverse sources is considered to be of equivalent quality.

Specialty chemicals, meanwhile, comprise a significant, albeit somewhat arcane segment of the U.S. chemical industry. Specialty chemicals are high value-added items, often produced to customer specifications, and sold on a performance basis.

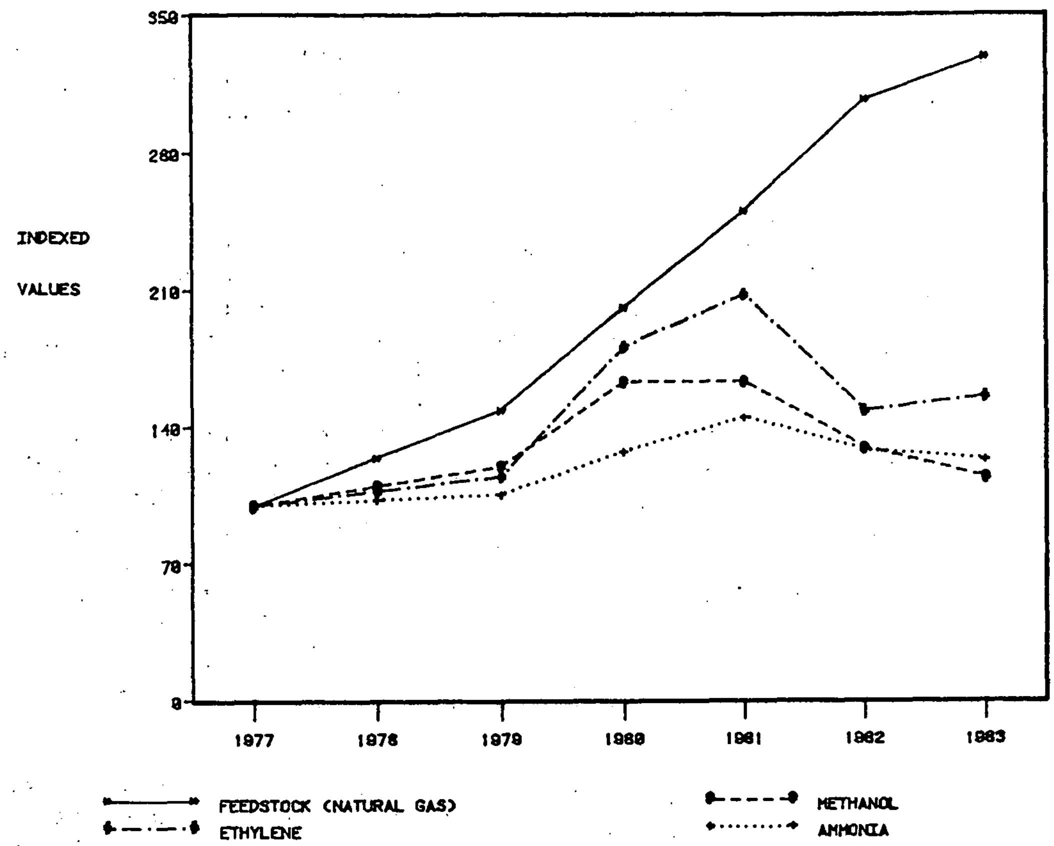
The following are the major findings of the Commission's investigation:

1. <u>U.S. PETROCHEMICAL INDUSTRY STATUS</u>

   o <u>Energy and feedstock costs of U.S. producers of commodity petrochemicals increased by almost 229 percent during 1977-83, while unit sales values increased by only 24 percent (ammonia) to 71 percent (ethylene)</u>.

The following figure shows indexed values for feedstock costs and unit sales value for three major commodity petrochemicals--ethylene, methanol, and ammonia.

1/ This study concentrates on those commodity petrochemicals which are derived from natural gas feedstocks.



The increased share of feedstock costs relative to other costs of production has become the primary concern of the industry. These costs, coupled with the declines in the unit sales values obtained by U.S. commodity petrochemical producers during 1979-85 (as typified by ethylene, methanol, and ammonia producers) created an economic climate in which increased pressures to remain competitive caused the U.S. producers to accept decreased levels of profitability.

o <u>The U.S. chemical industry's share of world chemical industry production, which had been declining through 1974, has been increasing since the period of the first crude petroleum price shock.</u>

The share of the value of world chemical industry sales held by U.S. domestic producers declined from 53 percent in 1960 to a low of 35 percent in 1974, as the Western European and Japanese chemical industries grew. The U.S. industry, which relies primarily on natural gas-based feedstocks, saw its share of world chemical sales increase from 35 percent to 41 percent during 1974-82, as other major chemical producers located in Western Europe or Japan, which depend primarily on crude petroleum-based feedstocks, did not fare as well. The following tabulation shows the value of the U.S. and world chemical industries' sales for selected years during the period 1960-82 (in billions of dollars):

Year	U.S.	World	Ratio U.S./World Percent
1960	26.6	50.0	53
1965	37.5	72.8	52
1970	49.3	105.2	47
1973	65.0	174.1	37
1974	81.4	229.7	35
1975	86.4	236.0	37
1976	101.4	263.4	38
1977	118.0	299.6	39
1978	129.4	350.1	37
1979	147.7	413.0	36
1980	162.5	462.7	35
1981	180.5	452.0	40
1982	172.8	421.7	41

2. WORLD PETROCHEMICAL INDUSTRY DEVELOPMENTS

o Traditional commodity petrochemical producers outside the United States, such as Western European and Japanese firms, were affected to a greater extent than U.S. producers by the crude petroleum price shocks, as producers in these nations were, and remain far more dependent on imported petroleum-based feedstocks than are U.S. producers.

The following tabulation shows the shares of Western European energy material consumption in 1983 which was satisfied by imports (in percent):

Petroleum	70
Natural gas	17
Coal	20

Nearly 40 percent of the imported petroleum originated from the Middle East, despite increased production within Western Europe from North Sea fields.

Because the increased cost of imported feedstocks caused decreased competitiveness, these Western European producers rationalized 1/ between 15 and 20 percent of certain commodity petrochemical production since 1979, and anticipate the necessity of more rationalization before previous levels of profitability can be restored.

The Japanese commodity petrochemical producers, who depend completely on imported feedstock and energy materials, have worked together, under the auspices of the Ministry of International Trade and Industry, to decide which plants would be closed in order to regain a viable level of competitiveness by 1985. Of the total 1982 Japanese commodity petrochemical capacity, 27.4 percent is to be eliminated by 1985.

1/ Rationalization involves the elimination of older, less-efficient production capacity in lieu of generally newer, state-of-the-art facilities, when a situation of over-capacity develops.

o Commodity petrochemical development in conventional energy-rich nations (CERN's)1/ is progressing, adding more competitive pressure to the already over-supplied world markets.

As reported in USITC Publication 1370, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in Conventional Energy-Rich Nations, during 1979-81 a significant number of CERN'S initiated programs to develop world-scale commodity petrochemical industries in an effort to build an industrial base for their economies. Much of the petrochemical production, based on low-cost available natural gas feedstock has begun entering the world market. Because these nations have not yet developed significant demand for these commodity petrochemicals in their domestic markets, as much as 90 percent of their production is expected to be exported to markets such as the United States, Western Europe, or Japan.

The Canadian commodity petrochemical industry development, located in the natural gas-rich Province of Alberta, is expected to enable Canadian producers to double their 1980 share of the world market for certain petrochemicals by 1990, particularly ethylene derivatives. Canadian methanol producers also expect to increase their domestic capacity three-fold between 1980 and 1990.

Commodity petrochemical development in Saudi Arabia based on low-cost, available feedstocks has been advancing at a faster pace than originally anticipated. The Saudi facilities, which are among the most efficient and modern plants in the world, and the marketing agreements with joint venture partners from the United States, Western Europe, and Japan, provide the Saudi producers with additional competitive advantages in the world market.

The development of additional commodity petrochemical capacity in other CERN's, such as Mexico and Nigeria, is progressing at a slower rate, but are likely to increase world commodity petrochemical capacity by a significant amount during 1990-95. 2/

o Energy and feedstock self-sufficiency highlight the nonmarket economies' potential for future commodity petrochemical development.

The major motivational force behind the plans for the development of export-oriented commodity petrochemical industries in the CERN'S is the need for foreign capital to purchase agricultural products from Western nations. The Soviet Union, with more than one-third of the world's proven reserves of natural gas available for use as a feedstock, now is reported to have the fourth largest chemical industry in the world.

1/ The term "CERN's" was coined to represent nations which are advantaged in terms of price and availability of crude petroleum and natural gas.

2/ "Remedying Petrochemical Excesses," Chemical Week, Jan. 2/9, 1985, pp. 26-27.

Because of its increasing agricultural requirements, the People's Republic of China is currently the third largest producer of fertilizers in the world. Other commodity petrochemical industrial expansion planned in China is just beginning, as chemical product substitution for items produced by "cottage industries" is creating the new demand for such commodity petrochemicals as plastics resins and synthetic rubber. These demands are expected to be satisfied by increasing domestic production capacity.

3. POSSIBLE STRATEGIES AVAILABLE TO THE U.S. PETROCHEMICALS INDUSTRY

- Changes in strategic goals for those producers of commodity petrochemicals located in traditional petrochemical-producing nations have been universally recommended by representatives of these nations' private and public sectors.

While the Japanese petrochemical industry has had legislated Government cooperation in its efforts to rationalize commodity petrochemical capacity and regain a desireable level of profitability, both U.S. and Western European petrochemical industry analysts have addressed the need for two major changes in the petrochemical industries based in these nations. The first would be a rationalization of existing commodity petrochemical capacity in order to bring capacity closer to current levels of commodity petrochemical demand. The second, and most often discussed strategy, would be a shift of emphasis from production of commodity petrochemicals to value-added specialty chemical products. This shift would be expected to reestablish a reliance within the U.S. petrochemical industry on the special talents, which enabled the U.S industry to become a world leader, primarily its preeminence in technological development and innovation.

Although much commodity petrochemical capacity has been rationalized in the United States and Western Europe since 1979, there still remains more available capacity than demand. With commodity petrochemicals produced in CERN'S beginning to enter the world markets, changes in the strategic orientation of many of the firms comprising the U.S. petrochemical industry have been reported in the trade literature. 1/

- Alternatives to complete changes in strategic orientation include such strategies as geographic, vertical, or horizontal diversification, or any combination of these strategies appropriate to the structure and organization of the firm in question.

1/ "How old Strategies Now Are Changing," Chemical Week, Oct. 26, 1983, pp. 50-52.

The availability of several distinct strategic avenues provides the U.S. chemical industry with multiple possibilities in terms of designing a tailor-made program for one particular company. Major U.S. commodity petrochemical producers have used one or more of these major routes in their attempt to regain levels of profitability currently unachievable by maintaining traditional business strategies for commodity petrochemicals. The most common strategies now being employed by U.S. commodity petrochemical producers in the domestic market are: (1) rationalization; (2) diversification, either vertical, horizontal, or even geographic; and (3) seeking a niche within well-bounded commodity/specialty areas.

However, other strategies which involve increasing interest in offshore production, licensing of proprietary technology to secondary users, and using the joint-venture avenue for entrance into new areas, thus allowing the risk for new projects to be absorbed by more than one firm, have also become increasingly common. In particular, U.S.-based producers with investments in commodity petrochemical capacity in CERN's are seen by many analysts as being in the most enviable position of all producers who have remained committed to retaining their commodity petrochemical orientation.

The open-door U.S. investment posture, which allows virtually unrestricted foreign investment in the U.S. chemical industry, is, however, not reciprocally available to U.S. investors in certain major commodity petrochemical-producing nations. U.S. petrochemical industry representatives have made public their fears that an increasing number of foreign governments will prohibit foreign investment, thus further restricting U.S. chemical industry options vis-a-vis the other major chemical-producing nations.

- <u>The reported "shift" from a strategic commodity petrochemical production orientation to a specialty chemical production strategy among U.S. producers may not exist to the extent generally believed</u>.

Although there are some U.S. commodity petrochemical companies which, because of the changing world energy and feedstock environment, have made strategic decisions to change their corporate structure by divesting or curtailing unprofitable operations and absorbing more profitable operations, these decisions have, in most cases, not been derived from a specific desire to alter their strategic orientation. The majority of U.S. commodity petrochemical producers in 1985 retain the same strategic orientation they had in 1974. The increase in the number and the share of the petrochemical operations which produce specialty chemicals is seen as a natural progression for these firms, as they seek to develop or acquire subsidiaries which can function as less competitive in-house outlets for their commodity petrochemical production,thereby increasing the value of their commodity petrochemical output. Also, most of the commodity petrochemical producers entering the specialty chemicals market are doing so by acquisition of existing companies, and not by the creation of new businesses.

4. POSSIBLE IMPLICATIONS OF CHANGES IN THE U.S. PETROCHEMICAL INDUSTRY

- Three alternate demand scenarios for petrochemicals were constructed to be used as input into the Department of Labor's Input/Output Model of the U.S. Economy. 1/ The results of this exercise were anticipated changes in industrial output, employment, and trade balances for the commodity petrochemical sectors, the specialty chemical sectors, the chemical and allied products industry, and the effects on the U.S. economy as a whole.

The base scenario for commodity petrochemicals anticipates an average annual demand growth rate for 1985-95 of slightly more than 4 percent, while the anticipated base scenario demand growth rate for specialty chemicals is approximately 5 percent. 2/ However, because of the fledgling nature of the specialty chemicals industry, the anticipated demand growth rates in some segments of the specialty chemicals sector, particularly those which are technologically advanced, far exceed anticipated growth rates for the specialty chemical sector in general, as shown in the following tabulation (in percent):

Segment	Anticipated annual growth rate during 1985-90
Oilfield chemicals--------	7
Electronics chemicals-----	13
Specialty polymers--------	9
Diagnostics---------------	10
Catalysts-----------------	5

- Projection of changes in total U.S. industrial output in 1995 related to the "shift" in the U.S. chemical industry were obtained using the U.S. Department of Labor Input/Output model of the U.S. economy. The base demand scenario indicated that total U.S. industrial output may increase by approximately $165 billion, 3/ when compared with the corresponding output values from 1980, while output for the chemicals and allied products industry may increase by $27.0 billion.

The following tabulation shows the anticipated changes in industry output from the 1980 situation, derived from the input/output model for each of the three scenarios (in billions of constant 1980 dollars). 4/

1/ The underlying assumptions of the three scenarios are detailed in the text on pages 149-169.

2/ Actual demand in the U.S. commodity petrochemicals sector in 1980 was $89.8 billion, actual demand in the specialty chemicals sector in 1980 was $11.0 billion.

3/ Constant 1980 dollars.

4/ Scenario I = Base scenario; Scenario II = Low demand growth scenario; and Scenario III = High demand growth scenario.

	1985	1990	1995
Chemical and allied products:			
Scenario I	-18.2	29.8	75.9
Scenario II	-18.2	4.1	27.0
Scenario III	-18.2	39.9	135.9
U.S. economy:			
Scenario I	-45.5	48.5	164.7
Scenario II	-45.5	4.0	54.9
Scenario III	-45.5	108.3	301.0

o <u>Base-scenario demand assumptions indicate that total U.S. employment levels could increase by 982,000 jobs during 1980-95, and employment in the chemicals and allied products industry could increase by 495,00 jobs during the same period as a result of changes in the U.S. chemical industry</u>.

The following tabulation shows similar statistics for anticipated U.S. employment changes related to the "shift" in the U.S. petrochemical industry (in thousands of jobs):

	1985	1990	1995
Chemical and allied products:			
Scenario I	-121	154	495
Scenario II	-121	25	176
Scenario III	-121	322	890
U.S. economy:			
Scenario I	-299	270	982
Scenario II	-299	4	360
Scenario III	-299	685	1,921

o <u>Base scenario trade projections indicate the possibility of increased commodity petrochemical import penetration, and the net trade balance in commodity petrochemicals turning into a deficit situation by 1990. However, the specialty chemicals sector is expected to show an increase in the net trade balance during 1980-90 from $1.7 billion to $2.3 billion, according to the base scenario</u>. 1/

1/ Constant 1980 dollars.

Base scenario projections show that the value of imports of commodity petrochemicals is anticipated to increase from $8.1 billion in 1980 to $17.0 billion in 1990, or at an average annual rate of about 8 percent, while the value of commodity petrochemical exports is anticipated to remain at approximately $16.3 billion. These changes would create a change in the net trade balance of the commodity petrochemicals sectors during 1980-90 from a surplus of $7.3 billion to a deficit of $700 million. The ratio of imports to consumption in this sector is also projected to increase, according to the base scenario, from 9.0 percent in 1980 to 16.5 percent in 1990.

The value of U.S. imports of specialty chemicals is expected to increase from $234 million in 1980 to approximately $400 million in 1990, or by an average annual rate of about 6 percent. Exports of specialty chemicals are expected to increase at a slower rate, as increased U.S. production is expected to be used primarily to satisfy increasing domestic demand. The ratio of imports to consumption in this sector is expected to increase from 2.2 percent in 1980 to 2.5 percent in 1990.

The following tabulation shows the integrated 1980 balance of trade picture and 1990 base scenario projection for the commodity petrochemicals sector and the specialty chemicals sector's trade balances (in millions of constant 1980 dollars):

	1980	1990
Commodity petrochemicals:		
Imports	8,095	17,000
Exports	16,345	16,300
Trade balance	7,250	-700
Specialty chemicals:		
Imports	234	400
Exports	1,937	2,675
Trade balance	1,703	2,275
Total petrochemical sectors:		
Imports	8,329	17,400
Exports	18,282	18,975
Trade balance	9,953	1,575

The low-demand case and high-demand case scenarios lead to an expected range of net trade balances for the commodity petrochemicals sector in 1990 from -$2.0 billion to $2.5 billion; the range of projected net trade balances in the total petrochemicals sector in 1990 would be from $275 million to $2.3 billion.

U.S. PETROCHEMICAL INDUSTRY STATUS

In April 1983, the United States International Trade Commission released a report concerning the probable impact on the U.S. petrochemical industry of the expanding petrochemical industries in the conventional energy-rich nations (CERN's). 1/ Certain major findings of this study indicated the need for further investigation into possible changes in the structure of the U.S. petrochemical industry. These findings included expectations that manufacturers of commodity petrochemicals 2/ which were located in traditional petrochemical-producing areas of the world 3/ would experience declining shares of world production capacity and resulting declines in net exports. A parallel finding was that certain developing countries, which could offer cost advantages and guarantee the availability of feedstock materials, primarily natural gas, to manufacturers of commodity petrochemicals would capture an increasing share of the world market through 1990.

Currently, as many of the planned petrochemical production facilities described in the April 1983 study are approaching completion, there is much conjecture among industry analysts as to the strategies to be employed by traditional producers of petrochemicals to remain internationally competitive. The focus of this report will be those industrial strategies. Particular attention will be paid to those strategies which may be employed by the U.S. petrochemical industry in order to provide continued growth possibilities and improved profitability.

The competitive situation in which the U.S. petrochemical producers find themselves today arose through a series of logical assumptions of growth which were based, at least partially, on expectations of the continuous availability of low-cost feedstocks, along with a continuation of historical trends in demand. U.S. production statistics for ethylene, methanol, and ammonia all showed similar growth patterns during 1955-74, as domestic consumption also steadily increased (tables 1-4). 4/ However, the crude petroleum price shocks in 1973-74 and 1979-80 changed the entire petrochemical industry's cost

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1/ The term "CERN's" was coined to represent nations which are advantaged in terms of price and availability of crude petroleum and natural gas.

2/ Commodity petrochemicals are defined in this study as chemicals generally derived from hydrocarbon sources such as crude petroleum, natural gas, or possibly coal; they are produced and marketed via characteristic high-volume low-profit-margin procedures. Commodity petrochemicals that are found in crude petroleum are the aromatics--benzene, toluene, and the xylenes. Ethylene and other olefins may be produced by "cracking" certain crude petroleum fractions, but are more often obtained from natural gas sources. Other commodity petrochemicals derived from natural gas sources are methanol and ammonia. Certain downline petrochemicals, such as polyolefin resins, may also be classified as commodity petrochemicals if the high-volume production, low-profit-margin traits are characteristic of their production and marketing.

3/ The traditional petrochemical-producing areas of the world are Western Europe, Japan, and the United States.

4/ Tables 2 and 4 show an index of U.S. production and consumption for ethylene, methanol, and ammonia during 1955-83 for easier comparability.

structure from that of an industry whose major costs were fixed capital costs for items such as machinery and equipment, to an industry dominated by variable costs, particularly for raw materials. For example, as late as December 1972, forecasts of world energy balances were assuming either continuous price increases or no real change in crude petroleum prices through 1985. 1/

Table 1.--Ethylene, methanol, and ammonia: U.S. production, 1955, 1960, 1965, and 1970-83

(In millions of pounds)

Year	Ethylene	Methanol	Ammonia 1/
1955	3,048	1,344	2/
1960	5,448	1,966	9,800
1965	9,570	2,869	17,800
1970	18,089	4,932	27,700
1971	18,450	4,950	29,200
1972	20,852	6,472	30,400
1973	22,329	7,064	30,500
1974	23,891	6,878	31,500
1975	20,499	5,176	33,000
1976	22,475	6,242	33,500
1977	25,426	6,473	35,600
1978	25,955	6,443	34,300
1979	29,904	7,367	37,200
1980	28,667	7,153	39,400
1981	29,418	8,577	38,070
1982	24,501	7,555	31,500
1983	28,680	7,982	27,400

1/ Compiled from official statistics of the U.S. Department of Commerce and the U.S. Department of Agriculture.
2/ Not available.

Source: U.S. International Trade Commission, Synthetic Organic Chemicals: U.S. Production and Sales, except as noted.

1/ National Petroleum Council, U.S. Energy Outlook, December 1972, pp. 305-308. Prices of crude petroleum from various foreign sources were expected (in 1970) to range in cost from $3.41 to $4.00 per barrel until 1985.

Table 2.--Ethylene, methanol, and ammonia: Index of U.S. production volume, 1955, 1960, 1965, and 1970-83

(1960 = 100)

Year	Ethylene	Methanol	Ammonia
1955	0.56	0.68	1/
1960	1.00	1.00	1.00
1965	1.76	1.50	1.82
1970	3.32	2.51	2.83
1971	3.39	2.52	2.98
1972	3.78	3.29	3.10
1973	4.10	3.59	3.11
1974	4.39	3.50	3.21
1975	3.76	2.63	3.37
1976	4.13	3.17	3.42
1977	4.67	3.29	3.63
1978	4.76	3.28	3.50
1979	5.49	3.73	3.80
1980	5.26	3.64	4.02
1981	5.40	4.36	3.88
1982	4.50	3.84	3.21
1983	5.26	4.06	2.80

1/ Not available.

Source: Derived from data in table 1.

Table 3.--Ethylene, methanol, and ammonia: Apparent domestic consumption, 1955, 1960, 1965, and 1970-83

(In millions of pounds)

Year	Ethylene	Methanol	Ammonia
1955	3,048	1,304	1/
1960	5,448	1,770	9,580
1965	9,570	2,674	17,480
1970	18,089	4,653	26,480
1971	18,450	4,373	28,680
1972	20,852	5,391	29,880
1973	22,329	6,237	30,780
1974	23,892	6,013	31,060
1975	20,496	4,827	32,180
1976	22,431	5,953	33,700
1977	25,356	6,475	35,900
1978	27,557	6,672	36,820
1979	29,947	7,379	40,240
1980	27,679	7,079	43,320
1981	27,250	7,912	41,020
1982	26,546	6,502	34,760
1983	29,030	-	-

1/ Not available.

Source: Compiled from official statistics of the U.S. Department of Commerce, the U.S. Department of Agriculture, and the U.S. International Trade Commission.

Table 4.--Ethylene, methanol, and ammonia: Index of U.S. apparent domestic consumption 1955, 1960, 1965, and 1970-83

(1960 = 100)

Year	Ethylene	Methanol	Ammonia
1955	0.56	0.74	1/
1960	1.00	1.00	1.00
1965	1.76	1.51	1.82
1970	3.32	2.62	2.76
1971	3.39	2.48	2.99
1972	3.83	3.05	3.12
1973	4.10	3.53	3.21
1974	4.39	3.40	3.24
1975	3.76	2.73	3.36
1976	4.12	3.37	3.52
1977	4.65	3.66	3.75
1978	5.06	3.77	3.80
1979	5.50	4.17	4.20
1980	5.08	4.00	4.52
1981	5.00	4.48	4.28
1982	4.86	3.68	3.63
1983	5.33		

1/ Not available.

Source: Derived from data in table 2.

Industrial costs for natural gas in the United States have also increased greatly, as can be seen in the following tabulation, which shows the average natural gas prices paid by domestic consumers during 1973-84 (in dollars per thousand cubic feet): 1/

Year	Wellhead prices	Imports	Industrial purchases
1973	0.22	1/	1/
1974	.30	1/	1/
1975	.44	1/	1/
1976	.58	1/	1/
1977	.79	1/	1/
1978	.91	2.21	1.54
1979	1.18	2.60	2.01
1980	1.59	4.42	2.54
1981	1.98	4.80	3.13
1982	2.46	4.97	3.72
1983	2.60	4.58	4.20
1984	-	-	-

1/ Not available.

The average wellhead price for natural gas increased by more than 1100 percent during 1973-83, while the average price paid for natural gas by U.S. industrial users increased by 173 percent during 1978-83. 2/ As natural gas was the predominant feedstock used in most older domestic primary petrochemical facilities, this price increase created much upward price pressure on domestic petrochemicals production, particularly during 1973-75 and 1978-80. The prices of U.S.-produced ethylene and methanol for the period 1972-83 are shown in the following tabulation (in cents per pound): 3/

1/ U.S. Department of Energy, Monthly Energy Review, January 1984, p. 93.
2/ Ibid.
3/ Data for ethylene and methanol derived from U.S. International Trade Commission, Synthetic Organic Chemicals, Production and Sales, USITC Publications 681, 728, 776, 804, 833, 920, 1001, 1099, 1183, 1292, 1422, 1972-83. The ammonia statistics are derived from the average prices paid by U.S. farmers for anhydrous ammonia to be used as fertilizer as reported by the U.S. Department of Agriculture.

Year	Ethylene	Methanol	Ammonia
1972	3.0	1	3.6
1973	3.3	2	3.8
1974	7.5	4	8.3
1975	8.8	6	12.0
1976	11.2	6	8.7
1977	12.0	6	8.5
1978	12.5	6	8.0
1979	14	7	7.8
1980	22	9	10.4
1981	25	9	11.0
1982	18	8	11.6
1983 1/	17	8	10.8
1984 1/	22	10	2/

1/ Estimated.
2/ Not available.

The rising prices for these primary commodity petrochemicals during 1973-83 contributed significantly to the declines in growth rate of their domestic consumption (table 2), and also paved the way for significant industry self-reappraisal toward the end of this period.

However, the domestic industry also continued to add considerable new capacity during the 10-year period, 1973-83, in anticipation of rapid continued growth into the next decade. When the anticipated growth did not materialize, the resulting overcapacity forced many firms to shut down older, less efficient plants so that the remaining plants could operate at profitable capacity utilization levels. 1/ Recent years have seen capacity utilization rates in operating U.S. commodity petrochemical plants fall below 75 percent 2/, the rate generally identified as necessary for generating reasonable profits for a world-scale facility. The following tabulation shows estimated capacity utilization rates for U.S. ethylene plants in 1970 and during 1975-84 (in millions of pounds capacity and percent capacity utilization): 3/

1/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional-Energy-Rich-Nations, USITC Publication No. 1370, April 1983, pp. 12-13.
2/ Compiled from official statistics of the U.S. International Trade Commission and U.S. Department of Commerce.
3/ "Chemical Capacity Utilization Rose in April from First Period '84 Level," Chemical Marketing Reporter, June 25, 1984, pp. 7, 20.

Year	Nameplate capacity	Effective capacity utilization
1970	20	91
1975	27	76
1976	28	80
1977	30	85
1978	32	78
1979	32	90
1980	36	84
1981	41	75
1982	40	62
1983	39	74
1984	38	1/ 91

1/ Projected using first quarter 1984 data.

Only in 1984 did operating rates allow U.S. ethylene producers to regain improved levels of profitability, although the situation did not come about solely because of increased demand. Much of the reason behind the apparently improved operating ratios lies in the idling of the older U.S. capacity (previously mentioned), as well as the current emphasis on building up inventories. 1/

Domestic producers of other natural gas-based petrochemicals, such as methanol, are also undergoing similar "shake-outs" in their markets. In 1984, domestic capacity of methanol amounted to 1.9 billion gallons per year, but as of January 1985, only 1.4 billion gallons of capacity remained operational. 2/ The realization of the expected major breakthrough for methanol use as a fuel would greatly expand the demand for methanol. However, this anticipated demand will most likely be supplied from new methanol plants located in Canada, Latin America, the Middle East, or the Far East. These new facilities now coming onstream, or in the planning or construction phases, will not only be fed with low-cost feedstocks and energy (natural gas prices of $.50 per 1,000 cubic feet -- one-sixth the U.S. price 3/) but will be based on the most modern technology. It is often the case that the same U.S. firms which are shutting down domestic production capacity have significant interests or investments in the newer offshore facilities, or are licensing their technology to others.

Other factors influencing corporate decisions to relocate production facilities in developing nations, as opposed to remaining in the United States, Western Europe, or Japan, involve expectations of growth in future

1/ "Chemical Capacity Utilization Rose in April from First Period '84 Level," Chemical Marketing Reporter, June 25, 1984, pp. 7, 20.
2/ "More Hitches in Methanol's Growth Plan," Chemical Business, June 1984, pp. 27-36.
3/ Ibid.

markets. Markets in developed areas of the world for certain petrochemicals and their products, primarily plastics, are seen as mature. These markets are expected to exhibit slow, steady, but not extremely profitable growth patterns. 1/ Markets in developing areas of the world, however, are expected to have the most potential for demand growth for petrochemical products such as plastics and synthetic fibers. Therefore, plants are being built where both the feedstocks are located and significant market growth is anticipated in the future.

Commodity Petrochemicals

Commodity petrochemicals are those particular products derived from hydrocarbon sources, such as petroleum or natural gas, which are sold primarily on a price basis to industrial consumers, or are sometimes consumed internally. There are usually several producers of each of these items, and all of these commodity materials are generally accepted as equivalent in quality. Primary commodity petrochemicals are those which are derived directly from the petroleum or gas feedstock: the products derived principally from petroleum liquids are called aromatics; 2/ methanol, ammonia, and the olefins 3/ are produced principally from natural gas liquids. 4/ Olefins may also be derived from the cracking of petroleum naphtha or other heavy petroleum liquids. Both of these sources of olefins are fractions derived from the crude petroleum refining process. The option to use either gas- or petroleum-derived feedstocks is seen as an advantage for a producer, allowing the producer to moderate upward swings in the price of either feed-stock by switching from one feedstock to the other. 5/ Figure 1 shows the distribution of the major petrochemical feedstocks used to produce ethylene in the United States. 6/ The share of natural gas-derived feedstocks used by U.S. producers began declining immediately following the first crude petroleum price shock and is expected to continue declining through 1995. 7/ Also, the production yields of ethylene and the other primary commodity petrochemicals may be manipulated at the discretion of the producer by altering the mix of feedstock materials. The following tabulation shows the typical yields from certain common petrochemical feedstocks (in percent): 8/

1/ "Pacific Rim Offers Both Promise, Frustration as Market," Chemical & Engineering News, Oct. 17, 1983, pp. 10-12.

2/ Aromatics may also be derived from coal sources.

3/ Ethylene and propylene are the major primary olefins.

4/ In the United States as well as in Canada, Mexico, and the Arabian Gulf nations.

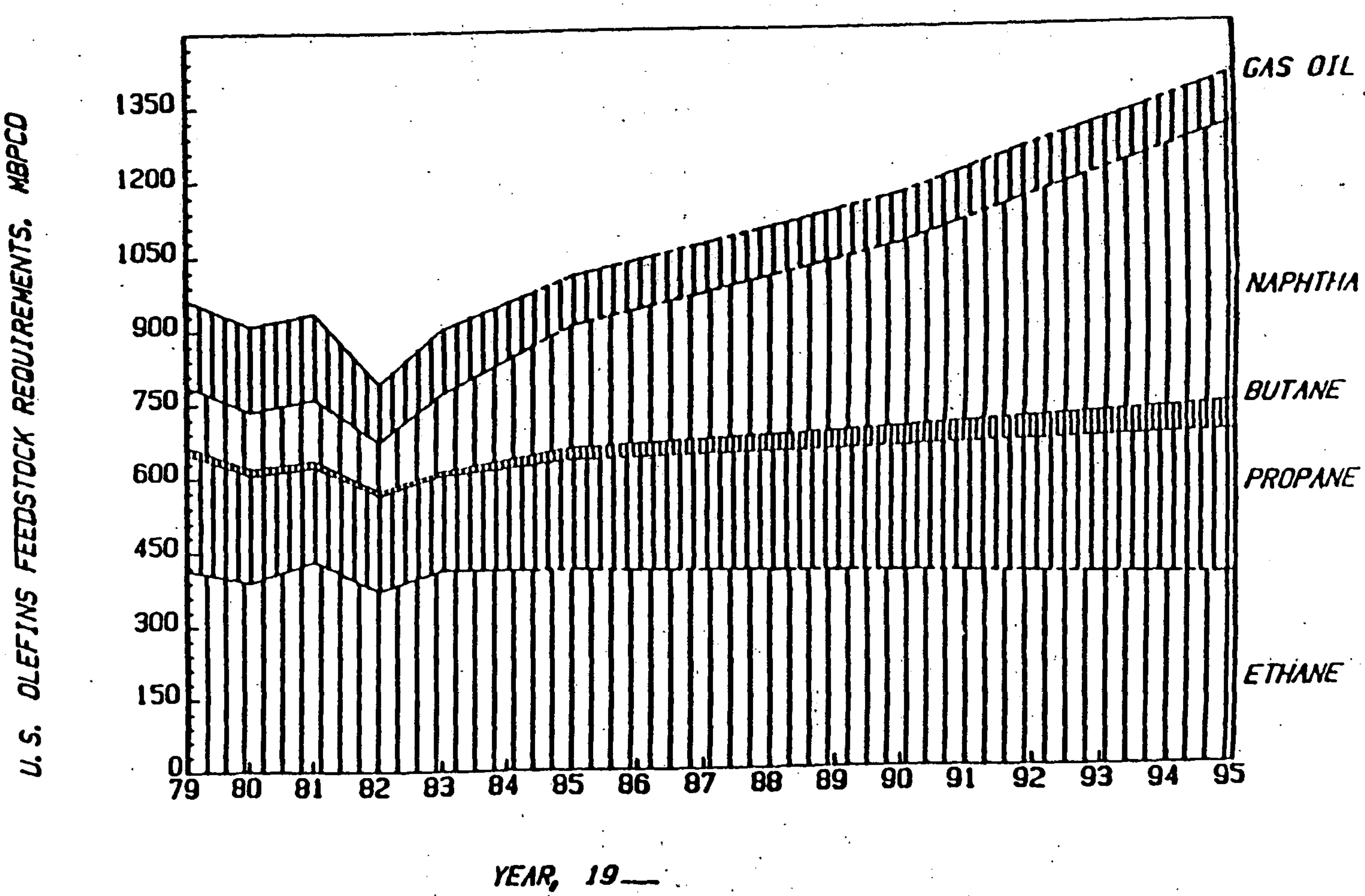
5/ "Olefin Producers are Revamping for Feedstock Flexibility to Reduce Operating Costs," Chemical Engineering, June 11, 1984, pp. 22-29.

6/ Lewis F. Hatch and Sami Matar, From Hydrocarbons to Petrochemicals, Gulf Publishing Co., Houston, Texas, 1981, pp. 71-91.

7/ Ibid.

8/ Ibid.

Figure 1.--Distribution of major petrochemical feedstocks to produce ethylene in the United States



Feedstock	Ethylene	Propylene	Butadiene	Aromatics
Ethane	84.0	1.4	1.4	0.4
Propane	44.0	15.6	3.4	2.8
n-Butane	44.4	17.3	4.0	3.4
Light naphtha	40.3	15.3	4.9	4.8
Full range naphtha	31.7	13.0	4.7	13.7
Light gas oil	28.3	13.5	4.8	10.9
Heavy gas oil	25.0	12.4	4.8	11.2

The increase in U.S. use of petroleum-based feedstocks may also help provide needed supplies of propylene, which may become more limited as certain developing nations base their new ethylene production on ethane, a natural gas feedstock.

The major part of the world's new primary commodity petrochemical production capacity is based on natural gas feedstocks, abundant in certain developing areas of the world. However, U.S. firms producing materials primarily from petroleum-based feedstocks (the aromatics--benzene, toluene, naphthalene, and the xylenes) have also been experiencing economic difficulties in recent years, related primarily to a slower growth in demand than originally forecast, although increasing competition from production located in CERN's may also be a factor. This slower growth pattern, in concert with expanding production capacity, has created an overcapacity situation in aromatics throughout the world. 1/

Other significant properties of the commodity petrochemical industry which are characteristic include the emphasis on high volume production and low profit margins. The need to sell a very large volume of commodity petrochemicals arises from the considerable capital expenditures for facilities ($1-$2 per annual sales dollar) and high variable costs, primarily for feedstocks. Production facilities must be monitored continuously and extremely well-maintained. Annual production quantities of companies often exceed one billion pounds for certain major products. Plants are operated on a 7 day-24 hour basis whenever possible in order to maximize their efficiency. 2/

Labor requirements and expenditures, both in terms of production personnel, and marketing and sales personnel, incurred in the production of commodity petrochemicals are relatively small compared to feedstock costs. The majority of sales are by contract agreements, with approximately $10 million of sales allocated annually to the average salesperson. The average sales cost to a commodity petrochemical producer remains minimal, as little

1/ "Supply/Demand of Benzene in the 1980's," and "Benzene Supplies and Sales into the 1990's," Chemical Engineering Processes, May 1984, pp. 13-16 and 19-22.

2/ Lewis F. Hatch and Sami Matar, From Hydrocarbons to Petrochemicals, Gulf Publishing Co., Houston, Texas, 1981, pp. 15-37 and 72-91.

advertising is necessary for promotion. Only an estimated industry-wide average of 10 percent of each sales dollar is allocated for marketing expenses. 1/

Figure 2 is a flow chart showing the progression of major commodity petrochemicals and their derivatives which may be produced from natural gas-based feedstocks.

Industry Structure

The structure of the domestic industry that produces commodity petrochemicals is extremely heterogeneous. There are major producers of these commodities whose operations are located entirely within the confines of the continental United States, while other domestic firms have operations and facilities located throughout the world. There are a few producers which, by choice, have limited their lines of production, and have not integrated forward into the production of value-added products; many more are integrated both horizontally and vertically. Those firms which exemplify a "typical" vertically integrated petrochemical producer may be refiners which use their hydrocarbon feedstocks to produce primary commodity petrochemicals. This production is often used internally by the vertically integrated firm as part of a general schemata to produce down-line value-added petrochemical products, such as plastics or fibers.

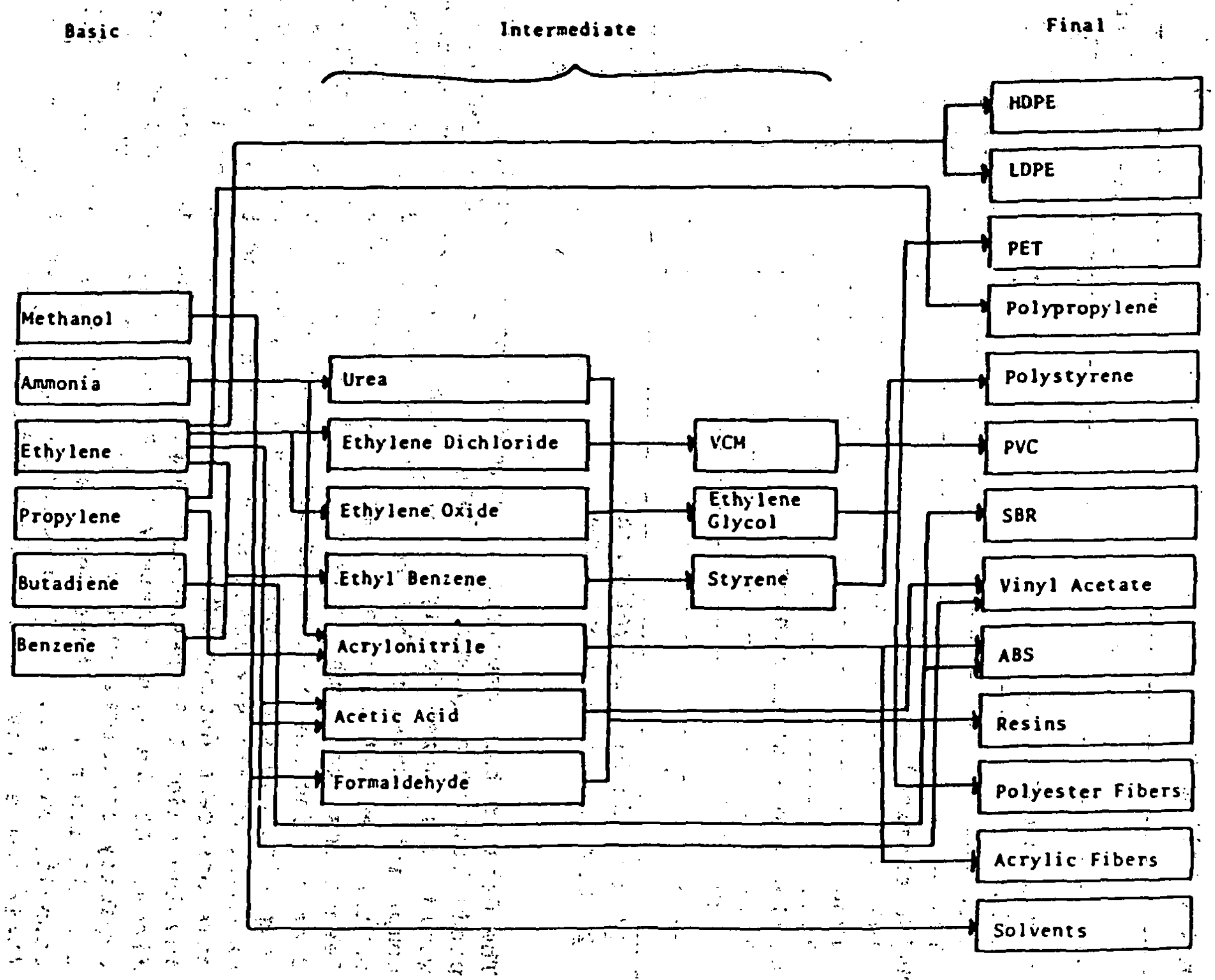
Producers that are horizontally integrated generally use their primary commodity petrochemicals to produce a wide range of value-added products. Such firms may produce any number of value-added products--surfactants, plastics, fertilizers, and synthetic rubber are examples of common areas of diversification traditionally chosen by primary commodity petrochemical manufacturers. 2/

Another major difference among U.S. manufacturers of commodity petrochemicals is their primary production orientation, be it as a petroleum company or a chemical company. For example, in the United States the share of ethylene capacity owned by petroleum-oriented companies was 54 percent in 1983, up from only 43 percent in 1976. Therefore, these firms may have a greater role in determining the direction of the U.S. commodity petrochemical industry than either of two other chemical-oriented groups. Those chemical producers who are vertically integrated comprise one of these groups and may be considered major chemical companies. The second chemical group is made up of smaller, less integrated firms, which generally need to purchase their feedstocks, not having direct access as do the petroleum companies and the

1/ Ibid, and United Nations Industrial Development Organization, Second World-Wide Study on the Petrochemical Industry: Process of Restructuring, May 1981, pp. 114-133.

2/ U.S. International Trade Commission, Study of the Petrochemical Industries in the Countries of the Northern Portion of the Western Hemisphere, USITC Publication 1123, January 1981, pp. 1-18.

Figure 2.--Major commodity petrochemicals produced from natural gas-based feedstocks, and their derivatives. 1/



1/ HDPE=high-density polyethylene; LDPE=low-density polyethylene; PET=polyethylene terephthalate; PVC=polyvinyl chloride; and ABS=acrylonitrile-butadiene-styrene.

major chemical companies. 1/ These firms usually limit their business to domestic trade and are not often involved in the international market.

The following tabulation shows the shares of production capacity for those major commodity petrochemicals that each of these producing groups owned in the United States in 1976, 1980, and 1983 (in percent): 2/

Source	Ethylene	HDPE 1/	LDPE 2/
Petroleum companies:			
1976	43	22	23
1980	53	37	28
1983	54	33	28
Major chemical companies:			
1976	40	43	44
1980	33	38	37
1983	33	38	40
Smaller chemical companies:			
1976	18	34	33
1980	14	26	35
1983	13	30	32

1/ High-density polyethylene.
2/ Low-density polyethylene.

The data in this tabulation indicate that the initial control over the production of ethylene, the largest volume commodity petrochemical in the world, was shared fairly equally among major petroleum companies and chemical companies. However, between 1976 and 1980 the U.S. petroleum firms brought onstream enough additional capacity, based primarily on petroleum liquids feedstocks, to assume a lead role in the production of ethylene in the United States. The share of world production controlled by the U.S. petroleum companies and U.S. chemical companies is not included in these data. As an example, of the six major Saudi Arabian commodity petrochemical projects that came onstream during 1984 or are expected to come onstream in 1985, three involve major U.S. petroleum companies and one involves two U.S. chemical firms. Of the approximately 1.6 million metric tons per year of ethylene capacity contained in these projects, U.S. firms have interests in more than 1.0 million metric tons per year. 3/ This share of new offshore 4/ production capacity owned by U.S. petroleum companies lends much additional strength to their competitive stature in the international market.

1/ United Nations Industrial Development Organization, Second World-Wide Study on the Petrochemical Industry: Process of Restructuring, May 1981, pp. 293-305.
2/ Ibid.
3/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional-Energy-Rich-Nations, USITC Publication No. 1370, April 1983, p. 60.
4/ Nondomestic.

In addition to the multinational operations owned by U.S. firms, there are a number of foreign-based multinational companies that have built U.S. domestic facilities, or bought smaller U.S. firms with domestic production in their own efforts to integrate and diversify. In most cases, these foreign firms are based in developed nations; European-based firms are prominent among multinationals with significant operations in the United States. West Germany, the United Kingdom, Switzerland, and the Netherlands together accounted for more than 71 percent of all foreign multinational investment in the U.S. chemical industry in 1982. 1/ The total value of foreign investment in the U.S. chemical industry, as estimated by the Department of Commerce, was approximately $9.3 billion in 1982. 2/ This represents an increase of 10 percent when compared with foreign investment in the U.S. chemical industry in 1981.

The open-door U.S. investment posture, which allows virtually unrestricted foreign investment in the U.S. chemical industry, is, however, not reciprocally available to U.S. investors in certain major commodity petrochemical-producing nations. 3/ PEMEX, the national energy and chemical company in Mexico restricts foreign investment in most chemicals to less than 40 percent, although the primary petrochemical industry, as defined by PEMEX, is owned and run totally by PEMEX, with no foreign investment allowed. France's largest chemical manufacturers have been nationalized and no investment opportunities for the U.S. domestic industry are available. The Canadian petrochemical industry is also somewhat resistant to foreign investment as legislated in Canada's Foreign Investment Review Act and National Energy Act. 4/ U.S. petrochemical industry representatives have made public their fears that an increasing number of foreign governments will prohibit foreign investment, thus further restricting U.S. chemical industry options vis-a-vis the other major chemical-producing nations. 5/

At the present time, the U.S. industry is facing increased competition in foreign markets from production facilities located in nations which have significant cost advantages when compared with U.S. firms with U.S. domestic plants. Foreign firms are also capturing much of the U.S. domestic market through acquisitions of U.S. production facilities. 6/ Together, these problems are forcing U.S. commodity petrochemical producers to encourage strategic planning processes. These processes would help improve and streamline the individual producer's structure and efficiency, thereby aiding the efforts to remain competitive in the international market.

1/ "The Growing Presence of Non-U.S. Owners," Chemical Week, Oct. 12, 1983, pp. 46-54.

2/ Ibid.

3/ Ibid.

4/ Ibid, pp. 46-47.

5/ Ibid.

6/ Ibid, and U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional-Energy-Rich-Nations, USITC Publication No. 1370, April 1983, pp. 15-37.

Competitive Status

Background

The competitive position of the U.S. producers of commodity petrochemicals changed dramatically several times during the last 12 years. Prior to the first crude petroleum price shock, the U.S. industry had available the most abundant, least expensive feedstock and energy resources of any nation in the world. Despite a declining share of the total world exports, U.S. chemical industry exports were extremely strong in the international marketplace during 1960-70. 1/ The value of U.S. exports accounted for 17 to 23 percent of all world chemical exports during this period (table 5). 2/ During this same period, the sales value of the U.S. chemical industry production accounted for

Table 5.--Chemicals: U.S. and world exports, 1960-83

Year	World exports	U.S. exports	U.S. share of world exports
	billion dollars		Percent
1960	7.45	1.72	23.1
1961	7.91	1.82	23.0
1962	8.50	1.88	22.1
1963	9.37	1.99	21.2
1964	10.91	2.37	21.7
1965	12.15	2.40	19.8
1966	13.57	2.68	19.8
1967	14.83	2.80	18.9
1968	16.97	3.29	19.4
1969	19.30	3.38	17.5
1970	22.11	3.83	17.3
1971	24.27	3.84	15.8
1972	29.15	4.13	14.2
1973	40.37	5.75	14.2
1974	64.06	8.82	13.8
1975	61.25	8.71	14.2
1976	68.76	9.96	14.5
1977	78.20	10.82	13.8
1978	96.47	13.61	14.1
1979	126.45	18.67	14.8
1980	147.64	22.79	15.4
1981	143.25	23.32	16.3
1982	135.96	20.21	14.9
1983	188.66	19.94	10.7

Source: Compiled from official statistics of the U.N. Trade Data System.

1/ Since world data for petrochemical trade does not exist, data for all chemicals are used to examine trends in international trade. Based on U.S. statistics, petrochemical trade probably accounts for more than 50 percent of all chemical trade; commodity petrochemical trade probably accounted for an average of more than 60 percent of all petrochemical trade since 1970.

2/ United Nations Monthly Bulletin of Statistics.

more than 50 percent of the sales value of worldwide chemical production (table 6). 1/ During this period, the overwhelming majority of the production consisted of primary commodity petrochemicals and commodity petrochemical intermediates.

During 1970-75, the cost of crude petroleum 2/ to the U.S. industry increased by more than 200 percent from $3.40 to $10.38 per barrel (table 7). The prices of domestic feedstocks also increased during the same period as the

Table 6.--Sales value of chemical industry production in Western Europe, Japan, and the United States 1/

Year	Western Europe	Japan	United States	World	U.S. share of world
	Billion dollars				Percent
1960	20.3	3.1	26.6	50.0	53
1961	21.6	3.5	27.3	52.4	52
1962	23.0	4.0	29.3	56.3	52
1963	24.4	4.5	31.8	60.7	52
1964	27.2	4.7	34.3	66.2	52
1965	29.8	5.5	37.5	72.8	52
1966	32.7	6.9	40.8	80.4	51
1967	35.6	8.4	42.4	86.4	49
1968	37.6	9.7	46.6	93.9	50
1969	40.0	11.4	48.8	100.2	49
1970 1/	43.0	12.9	49.3	105.2	47
1971	52.6	16.5	51.9	121.0	43
1972	61.7	19.5	58.2	139.4	42
1973	81.8	27.3	65.0	174.1	37
1974	113.2	35.1	81.4	229.7	35
1975	115.4	34.2	86.4	236.0	37
1976	123.8	38.2	101.4	263.4	38
1977	130.9	50.7	118.0	299.6	39
1978	161.0	59.7	129.4	350.1	37
1979	210.0	55.3	147.7	413.0	36
1980	237.0	63.2	162.5	462.7	35
1981	212.0	59.5	180.5	452.0	40
1982	192.0	56.9	172.8	421.7	41
1983	-	-	202.9	-	-

1/ The OECD definition of the Chemical Industry excluded synthetic fibers and synthetic rubber through 1969. Synthetic fibers were includes starting in 1970. Sales data includes exports.

Source: Organization for Economic Cooperation and Development, The Chemical Industry, annual publication.

1/ Organization for Economic Cooperation and Development, The Chemical Industry, 1960-83.

2/ As indicated by the U.S. refiner acquisition costs, official statistics of the U.S. Department of Energy.

average annual wellhead price of U.S. crude petroleum increased by 138 percent, from $3.18 to $7.56 per barrel (table 8). The price of U.S.-produced natural gas also increased steeply, as the average annual wellhead price increased by more than 160 percent, from 17.1 cents to 44.5 cents per thousand cubic feet (table 8). Despite this increase in feedstock and energy costs, the producers of commodity petrochemicals, both domestic and foreign,

Table 7.--Crude petroleum: Refiner acquisition cost, 1970-83

(Dollars per barrel)

Year	Domestic	Imported	Composite
1970	3.46	2.96	3.40
1971	3.68	3.17	3.60
1972	3.67	3.22	3.58
1973	4.17	4.08	4.15
1974	7.18	12.52	9.07
1975	8.39	13.93	10.38
1976	8.84	13.48	10.89
1977	9.55	14.53	11.96
1978	10.61	14.57	12.46
1979	14.27	21.67	17.72
1980	24.23	33.89	28.07
1981	34.33	37.05	35.24
1982	31.22	33.55	31.87
1983	28.87	29.30	28.99

Source: U.S. Department of Energy, Annual Energy Review and Monthly Energy Review.

experienced growth during this period. The value of U.S. production of all chemicals increased during 1970-75 from $49.3 billion to $86.4 billion, or by 75 percent, although the U.S. share of world production declined from 47 percent to 37 percent. 1/ This apparent statistical contradiction resulted from two factors, major expansions of production capacity throughout the world designed to take advantage of increasing profits from the production of commodity petrochemicals, and the world's economic situation in which unit values of these chemicals were rapidly increasing because of inflation. During 1970-75, the total value of chemical production from the three traditional petrochemical-producing areas of the world, the United States, Japan, and Western Europe, increased by more than 124 percent. 2/

1/ OECD, op. cit.
2/ Ibid.

Table 8.--Crude petroleum and natural gas: U.S. average annual wellhead price, 1955-83

Year	Crude petroleum: Price in current dollars	Crude petroleum: Price in 1967 constant dollars	Natural gas: Price in current dollars	Natural gas: Price in 1967 constant dollars
	Per barrel		Per thousand cubic feet	
1955	2.77	3.15	10.4	11.8
1956	2.79	3.08	10.8	11.9
1957	3.09	3.31	11.3	12.1
1958	3.01	3.18	11.9	12.6
1959	2.90	3.06	12.9	13.6
1960	2.88	3.03	14.0	14.8
1961	2.89	3.06	15.1	16.0
1962	2.90	3.06	15.5	16.4
1963	2.89	3.06	15.8	16.7
1964	2.88	3.04	15.4	16.3
1965	2.86	2.96	15.6	16.1
1966	2.88	2.89	15.7	15.7
1967	2.92	2.92	16.0	16.0
1968	2.94	2.87	16.4	16.0
1969	3.09	2.90	16.7	15.7
1970	3.18	2.88	17.1	15.5
1971	3.39	2.98	18.2	16.0
1972	3.39	2.85	18.6	15.6
1973	3.89	2.89	21.6	16.0
1974	6.74	4.21	30.4	19.0
1975	7.56	4.32	44.5	25.4
1976	8.14	4.45	58.0	31.7
1977	8.57	4.41	79.0	40.7
1978	8.96	4.28	90.5	43.2
1979	12.51	5.31	117.8	50.0
1980	21.59	8.03	159.0	59.2
1981	31.77	10.83	198.0	67.5
1982	28.52	9.53	243.0	81.2
1983	26.19	8.64	260.0	85.8

Source: Compiled from official statistics of the U.S. Energy Information Administration.

During the same period, the value of the total world chemical export market increased from $22.1 billion to $61.3 billion, or by 177 percent. Exports from Western European nations, particularly the Netherlands 1/ and the United Kingdom, accounted for much of the shift, as trade among European Economic Community (EEC) nations increased, and expanding European production was used to satisfy increasing demand in developing nations.

The growth in U.S. exports of commodity petrochemicals continued during 1975-80, as U.S. exports of all chemicals increased at annual rates ranging from 9 to more than 37 percent. However, as the effects of the second crude petroleum price shock and the recession lowered actual demand levels for ethylene, ethylene derivatives, methanol, and ammonia, and the petrochemical industry around the world continued to develop and increase production capacity for these items, the U.S. industry began to lose its previous competitive advantage. 2/

Much commodity petrochemical capacity throughout the world has been idled in a general rationalization process. In Japan, where cooperation among individual producing firms and Government ministries does not violate anti-trust laws, much progress has been made toward a complete rationalization. The Japanese Government, through a temporary measures law, has eliminated much ethylene industry competition. Meanwhile, the industry is in the process of closing down more than 5 billion pounds per year of ethylene capacity; more than one-third of the entire Japanese ethylene industry is expected to be shut down by April 1985. 3/ Although U.S. producers of ethylene and ethylene derivatives, methanol, and ammonia, have not been able to coordinate alterations in commodity petrochemical capacity in the same manner, much domestic capacity has been idled. Those changes in the specific items will be discussed individually in more detail.

In general, the U.S. Gulf Coast, Canadian, and Middle Eastern producers are expected to maintain certain competitive advantages involving raw material costs, which developed as energy prices increased, as compared with Western European and Japanese producers. 4/ However, these events depend significantly on the assumption that demand for petroleum, and therefore the price of petroleum, will increase over the long-term. 5/ The development of the current U.S. competitive status during 1979-84 concerning commodity petrochemicals may best be described by using the specific commodity petrochemicals mentioned previously as examples.

1/ Although the Netherlands accounted for a large share of the chemical trade in and out of Western Europe, the majority of the production is located in West Germany and France.

2/ Ibid, and U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional-Energy-Rich-Nations, USITC Publication No. 1370, April 1983, pp. 141-196.

3/ "International Meeting Examines Outlook for Petrochemicals Sector," Chemical Engineering, Nov. 14, 1983, pp. 61-66.

4/ Ibid.

5/ "The Commodity Petrochemical Industry's Position Will Improve in 1984," Chemical Marketing Reporter, Jan. 16, 1984, pp. 4, 50.

Recent developments

Ethylene.--The following tabulation shows the cost of ethylene feedstocks, 1/ the comparative unit sales values, 2/ and the published prices 3/ for ethylene 1972, 1977, and 1979-83 (in cents per pound):

Year	Feedstock cost	Unit sales values	List prices
1972----------	18.6	3.0	1/
1977----------	79.0	12.0	12.0-12.5
1979----------	117.8	13.8	15.5-18.0
1980----------	159.0	21.7	22.3
1981----------	198.0	24.9	25.5-28.5
1982----------	243.0	17.8	21.5
1983----------	260.0	18.7	26-27

1/ Not available.

In order to better see and compare the relative changes in these data, the following tabulation shows these same statistics converted to an indexed form (1977 = 100; in percent):

Year	Feedstock cost	Unit sales values	List prices 1/
1972----------	23.5	25.0	2/
1977----------	100.0	100.0	100.0
1979----------	149.1	115.0	136.7
1980----------	201.3	180.8	182.0
1981----------	250.6	207.5	216.0
1982----------	307.6	148.3	175.5
1983----------	329.1	155.8	216.3

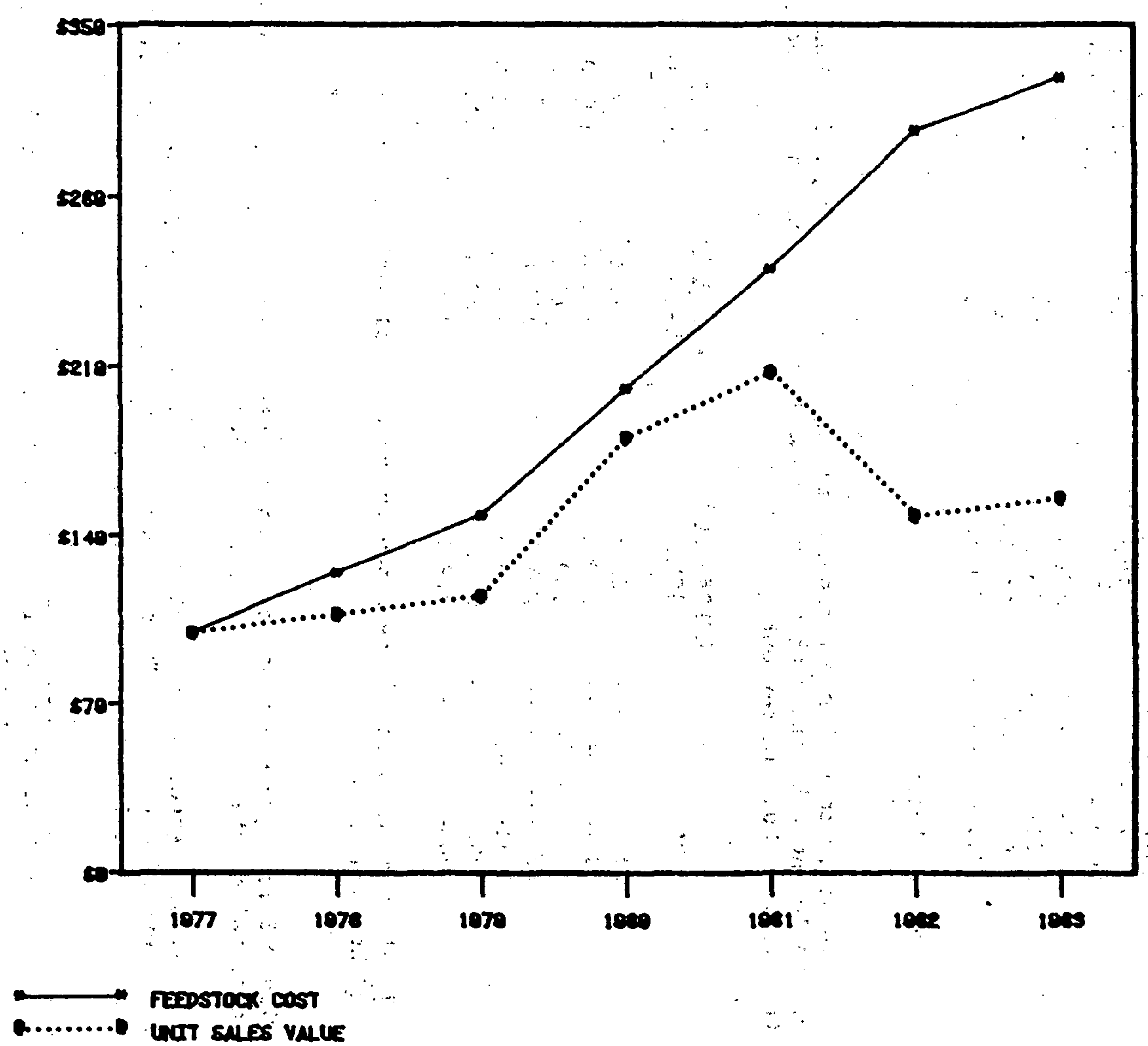
1/ The median value of the range is used to calculate the index.
2/ Not available.

Figure 3 is a graphic representation of the indexed feedstock cost and unit sales value data in the previous tabulation.

These figures are indicative of the competitive position of U.S. producers of ethylene. While feedstock costs have increased by more than 229 percent during 1977-83, the unit sales value increased by only 56 percent.

1/ U.S. average annual wellhead price of natural gas, taken from Table 7; cents per thousand cubic feet.
2/ U.S. International Trade Commission, Synthetic Organic Chemicals, Production and Sales, annual publication.
3/ Chemical Marketing Reporter, various issues; prices are list prices as of the 4th quarter.

FIGURE 3.--ETHYLENE: FEEDSTOCK COST AND UNIT SALES VALUE INDEXES



The increase in ethylene capacity in areas where feedstock costs are much lower and the feedstocks are more easily available have placed increased pricing pressure on domestic producers. Domestic ethylene feedstock pricing pressure is expected to continue into the next decade, as ethane remains the feedstock of choice for most U.S. producers. Demand for ethane will be limited by supply, thus further increasing the feedstocks cost burden to be felt by the domestic ethylene producer. Figure 4 shows the present and estimated future demand for ethane in the United States, both for chemical feedstock and other aggregated purposes. The feedstock pricing pattern in the United States is further complicated by such factors as the deregulation of natural gas and the increased availability of certain petroleum liquids for ethylene production. 1/

The following tabulation shows some consensus industry estimates of net trade data for ethylene derivatives 2/ in terms of ethylene equivalents (in millions of pounds): 3/

	United States	Western Europe	Japanese
Production--------	28,700	1/ 22,200	1/ 7,900
Capacity----------	37,700	32,00	12,000
Operating rate---	76	69	66
Net exports -----	3,688	1/ 471	1/ -59
Price 2/----------	18-20	21-22	3/

1/ 1982 data.
2/ As of Oct. 29, 1984, European Chemical News, in cents per pound.
3/ Not available.

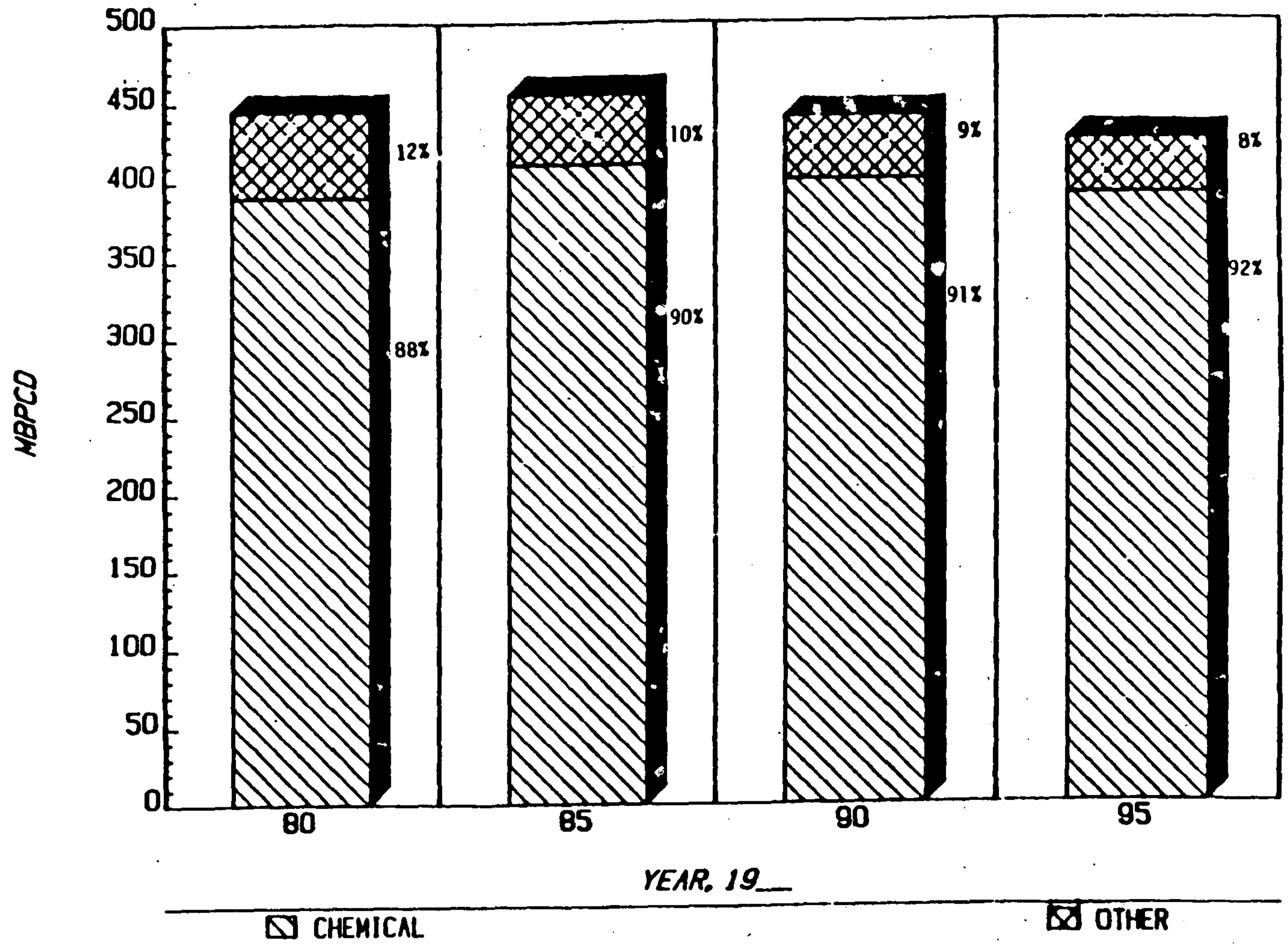
1/ "Ample World Ethylene," European Chemical News, Oct. 29, 1984, pp. 9-10.

2/ Derivatives, in ethylene equivalents. Ethylene equivalent is the number of pounds of ethylene used to make a pound of ethylene derivative. For example, each pound of ethylene oxide produced requires 0.91 pounds of ehtylene, and each pound of low-density polyetheylene made requires 1.02 pounds of ethylene. The conversion equivalents are taken from the February 1982 issue of the National Petroleum Refiners Association's monthly publication entitled, Selected Petrochemical Statistics: U.S. Trade Production and Consumption.

Ethylene equivalents enter trade in the following manner. Even if a country does not export or import ethylene as such, it is exporting or importing ethylene when it exports or imports ethylene derivatives. For example, for each pound of ethylene oxide traded, 0.91 pounds of ethylene are traded. Thus, if a nation produced 1000 pounds of ethylene oxide and then exported all the ethylene oxide, the country would essentially be exporting all of its ethylene production. The ultimate justification for the ethylene capacity would not be the domestic market, but rather the export market. A large portion of the ethylene capacity buildup in the CERN's is based on the movement of the ethylene produced into the world market.

3/ Compiled from industry estimates and official statistics of the U.S. Department of Commerce. All data shown are estimated for 1983, unless otherwise indicated.

Figure 4.--Ethane: U.S. domestic demand



Other major statistics for U.S. producers of ethylene indicate that capacity continued to decline through 1984, as total capacity dropped from a peak of 41 billion pounds per year in 1982 to approximately 37 billion pounds per year in 1984. Increased operating ratios reaching 78 percent of installed capacity were at least partially a result of extended maintenance on some older plants. A number of estimates have placed the total of permanently and temporarily idled U.S. capacity at about 20-25 percent of installed capacity during 1982-83. 1/

The positive trade balance in ethylene derivatives also has begun to decline, as exports fell from 3.96 million pounds in 1982 to less than 3.86 billion pounds in 1983. This decline continued during January-July 1984, as exports in terms of ethylene equivalents declined to 2.07 billion pounds from 2.34 billion pounds during the corresponding period in 1983. 2/

The current competitive situation for the domestic industry, as portrayed by these statistics, is viewed by industry analysts as likely to remain for the immediate future. 3/ Despite the changes already seen in the domestic industy, including the significant idling of capacity and the decreased profit margins, industry analysts expect the need for more reductions in capacity, or some other change in production philosophy to persist through the late 1980's. 4/

Methanol.--The following tabulation shows the unit sales values 5/ and list prices 6/ for methanol in 1972, 1977, and during 1979-83 (in cents per gallon):

Year	Unit sales value	List price
1972	9.6	10.0
1977	38.4	42.0
1979	45.9	46.0
1980	62.5	71.0
1981	62.5	79.5
1982	49.6	71.5
1983	43.9	72.0

1/ "Ethylene Report," Oil & Gas Journal, Sept. 3, 1984, pp. 55-59.
2/ National Petroleum Refiners Association, Selected Petrochemical Statistics, July 1984, p. 28-30.
3/ "Basic Petrochemical Slowdown is Expected Through Mid-1990's," Chemical Marketing Reporter, Oct. 10, 1983, pp. 4 and 15, and J. D. DeWitt, "The Needs and Progress in U.S. Chemical Rationalization," presented at ECMRA Conference, Oct. 17, 1983.
4/ J. D. DeWitt, op. cit., and Peter Spitz, "Restructuring an Industry," Chemtech, June 1984, pp. 338-344.
5/ U.S. International Trade Commission, Synthetic Organic Chemicals, Production and Sales, annual publication.
6/ Chemical Marketing Reporter, various issues; prices are list prices as of 4th quarter.

Although data for 1984 are not yet available, actual market prices for methanol on the U.S. gulf coast fell to 39 cents per gallon during June 1984. 1/ In order to better compare the price data during 1979-83 with feedstock costs, the following tabulation lists indexed data on the cost of natural gas feedstock along with the indexed methanol price data (1977 = 100):

Year	Feedstock cost	List price	Unit sales value
1972	23.5	23.8	25.0
1977	100.0	100.0	100.0
1979	149.1	109.5	119.5
1980	201.3	169.0	162.8
1981	250.6	189.3	162.8
1982	307.6	170.2	129.2
1983	329.1	171.4	114.3

A graphic representation of the indexed feedstock cost and list price data is contained in Figure 5.

As can be seen from data in the preceding tabulations which show producer costs since 1977 increasing by 229 percent and unit sales prices increasing only by 14 percent, the U.S. producers of methanol have been forced to sell their methanol production for very close to the cost of production. A very large shift in foreign methanol operating capacity in 1983 and 1984, which forced approximately 100 million gallons of methanol, once targeted for export, back into the domestic market, contributed significantly to the depressed domestic price. 2/

The following tabulation shows the new methanol capacity which came onstream during 1983-84 and other projected entrants into the international methanol market during 1984-85, where they are located, and their capacities (in million of gallons per year): 3/

1/ CPI Purchasing, October 1984, p. 49.
2/ Chemical & Engineering News, Jan. 30, 1984, p. 13.
3/ "Large-Volume Fuel Market Still Eludes Methanol," Chemical & Engineering News, July 16, 1984, pp. 9-16.

Source	1983	1984	1985
Middle East:			
Saudi Arabia	220		220
Libya		110	
Bahrain		110	
Asia Oceania:			
New Zealand	130		500
India		16	
Malaysia		220	
Burma		50	
Indonesia			110
Western Hemisphere:			
United States	360		
Trinidad		130	
Non-Market Economies:			
Soviet Union	275	275	
East Germany		220	
Total	710	911	1,325

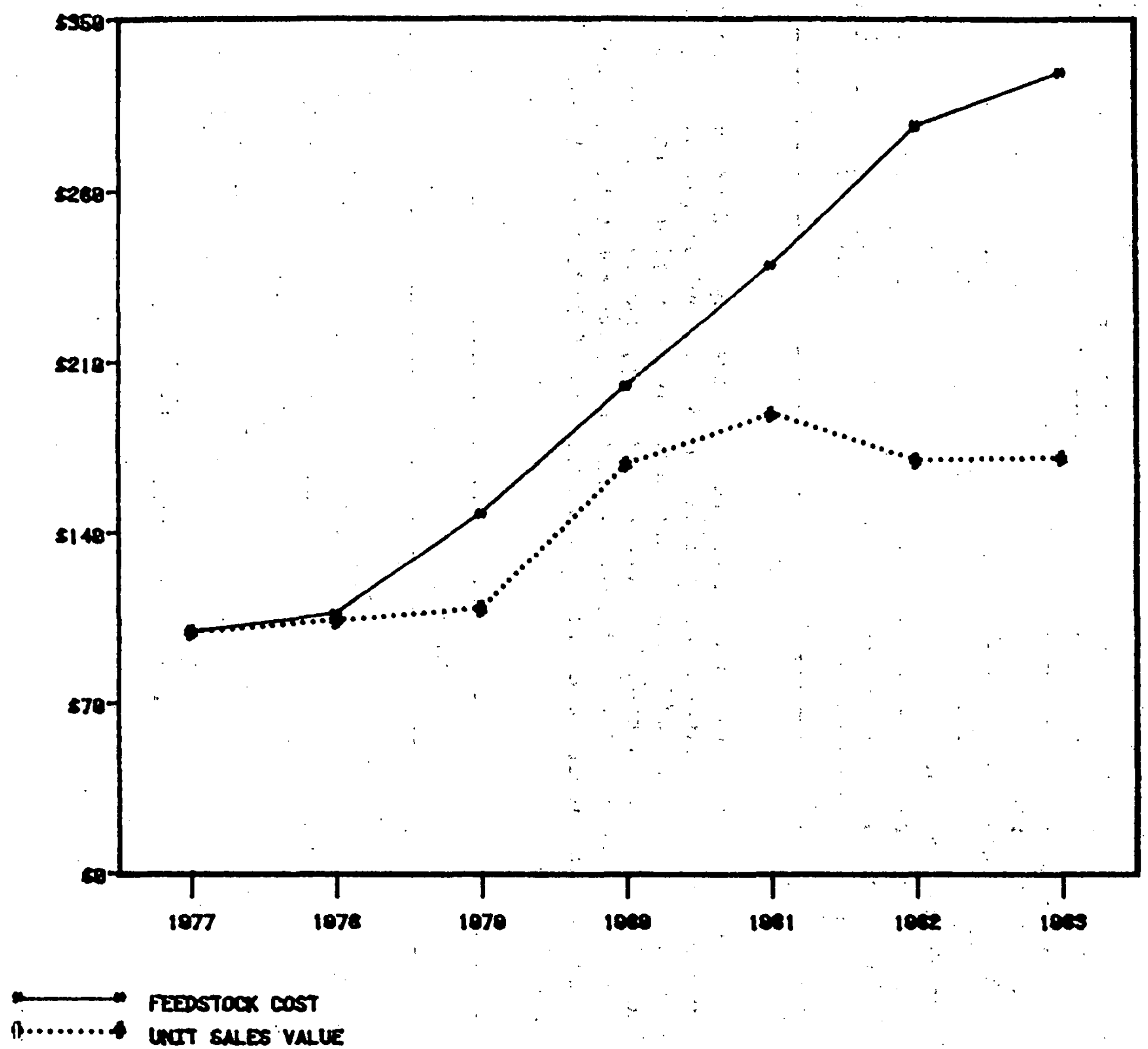
This increase in methanol production capacity of 2,946 million gallons during 1982-85 represents an increase of 61 percent in global methanol capacity. With the addition of the three methanol plants in the United States in 1983, total U.S. capacity accounted for approximately 40 percent of the world's capacity. The following tabulation shows how U.S. methanol capacity compares with other major world producers as of 1982 (in millions of gallons): 1/

Source	Capacity	Share of total
		Percent
United States	1/ 21,000	40
Western Europe	1,000	19
Japan	420	8
Other	1,760	33
Total	5,280	100

1/ Includes plants which were permanently idled.

1/ Compiled from data published in the following industry publications: Chemical & Engineering News, CPI Purchasing, and Chemical Marketing Reporter.

FIGURE 5.—METHANOL: FEEDSTOCK COST AND UNIT SALES VALUE INDEXES



In 1983, however, the U.S. producers of methanol did not share the improved economic position and improved profit margins of domestic ethylene producers. 1/ Domestic methanol production fell for the second consecutive year, despite the new capacity which came onstream. The following tabulation shows domestic methanol production for 1972, 1977, and during 1979-83 (in millions of gallons): 2/

Year	Production
1972	980
1977	977
1979	1,112
1980	1,084
1981	1,300
1982	1,100
1983	1,004

U.S. production in 1983 fell to less than 63 percent of total available capacity; the actual operating rate of plants that were onstream was approximately 88 percent, since a significant share of the domestic capacity was temporarily shut down. 3/

Domestic methanol demand, especially for gasoline blending stock, is expected by many industry analysts to increase by 17 percent in 1985. 4/ However, the large new capacity additions are expected to keep both the international and the domestic methanol markets in a situation where there is much more methanol available than is demanded. Much of the methanol brought into the market by the new producers in Canada and the Middle East will probably be priced at or possibly below the current depressed market price. Industry analysts also expect that the volumes of new methanol production expected to be imported into the United States will increase the total volume of imports from approximately 100 million gallons in 1983 to more than 330 million gallons in 1987. 5/ The majority of this expected increase in imports will probably originate in Canada and Trinidad. It is also expected that a significant amount of these increased methanol imports will be targeted for use as a fuel additive, as methanol may enter the United States duty-free if it is to be used in such a manner. 6/

1/ Chemical & Engineering News, Jan. 30, 1984, p. 13.
2/ Data extracted from Table 1.
3/ Chemical & Engineering News, Jan. 30, 1984, p. 13.
4/ CPI Purchasing, October 1984, p. 49.
5/ Ibid.
6/ Ibid.

The return to a strong competitive position for the U.S. methanol industry depends to a significant extent on methanol's potential for fuel use. If the price of crude petroleum remains stable, or decreases in real terms, the demand for methanol will increase, but not at a sufficient rate to restore to production much of the U.S. idled capacity. 1/ If, however, the price of crude petroleum increases as happened during 1973-74 and 1978-79, the potential for methanol to be used as a fuel for motor vehicles may increase greatly, both as a neat fuel and as a blending stock for traditional gasoline. 2/ A methanol-to-high-octane, unleaded gasoline process will be commercialized for the first time in New Zealand in 1985 in order to supplant part of the imported crude petroleum required in that nation. Although the process would be compatible with traditional refining and distribution systems in the United States, it is not economically feasible for domestic implementation at the present time. 3/

Ammonia.--The following tabulation compares the cost of the ammonia feedstocks with the unit value of ammonia-product shipments for 1972, 1977, and 1979-83 (in cents per pound): 4/

Year	Feedstock cost	Ammonia unit value 1/
1972	18.6	1.8
1977	79.0	5.1
1979	117.8	5.4
1980	159.0	6.5
1981	198.0	7.4
1982	243.0	6.5
1983	260.0	6.3

1/ Annual estimates based on published industry prices throughout the years.

As with the ethylene and methanol price data, the ammonia price data, along with the feedstock costs, are indexed (1977 = 100) in the following tabulation (in percent).

Year	Feedstock cost	Ammonia unit value
1972	23.5	35.3
1977	100.0	100.0
1979	149.1	105.9
1980	201.3	127.5
1981	250.6	145.1
1982	307.6	127.9
1983	329.1	123.5

1/ "More Hitches in Methanol's Growth Plan," Chemical Business, June 1984, pp. 27-36.
2/ CPI Puchasing, October 1984, p. 49.
3/ Ibid.
4/ Derived from official statistics of the U.S. Department of Commerce, except as noted.

A graphic representation of the data from the preceding tabulation is found in Figure 6.

Ammonia producers, whose product is used either directly as a fertilizer or as a feedstock for other fertilizer materials, experienced a strongly competitive period during 1980-83, as is indicated in the previous tabulation. Factors which have contributed to the intense competitive environment in the ammonia and fertilizer industries in recent years are the maturity of the ammonia industry itself, along with expansion of ammonia production capacity located in areas where feedstock costs to producers may be as low as one-sixth that of feedstock costs to U.S. producers. For example, the Saudi Basic Industries Corporation (SABIC) recently announced plans to construct their third world-scale ammonia plant, which will have a capacity of 550,000 metric tons per year. This expansion is estimated to bring total Saudi ammonia capacity to 1.4 million tons per year, while the Saudi domestic consumption is approximately 130,000 tons, leaving more than 90 percent of their production for the export market. 1/

The following tabulation highlights other expansions of ammonia capacity, 2/ which, in all likelihood, will compete with present U.S.-produced ammonia in the future (in thousands of metric tons per year): 3/

Area	Capacity
Far East----------------	4,958
Middle East-------------	1,958
Western Europe----------	1,727
U.S.S.R-----------------	5,180
North America:	
Canada----------------	1,397
Mexico----------------	730
United States---------	74

These facilities either came onstream after 1981 or are expected to be operational by 1986.

Very little of the output of the export-oriented ammonia plants located in natural gas-rich areas of the world has been earmarked for the United States. However, as more developing nation's fertilizer markets become saturated, the United States will become a likelier market for the excess low-cost international capacity. 4/ In that event, the U.S. industry would most likely be placed in an even more competitive situation than it experienced during 1980-83.

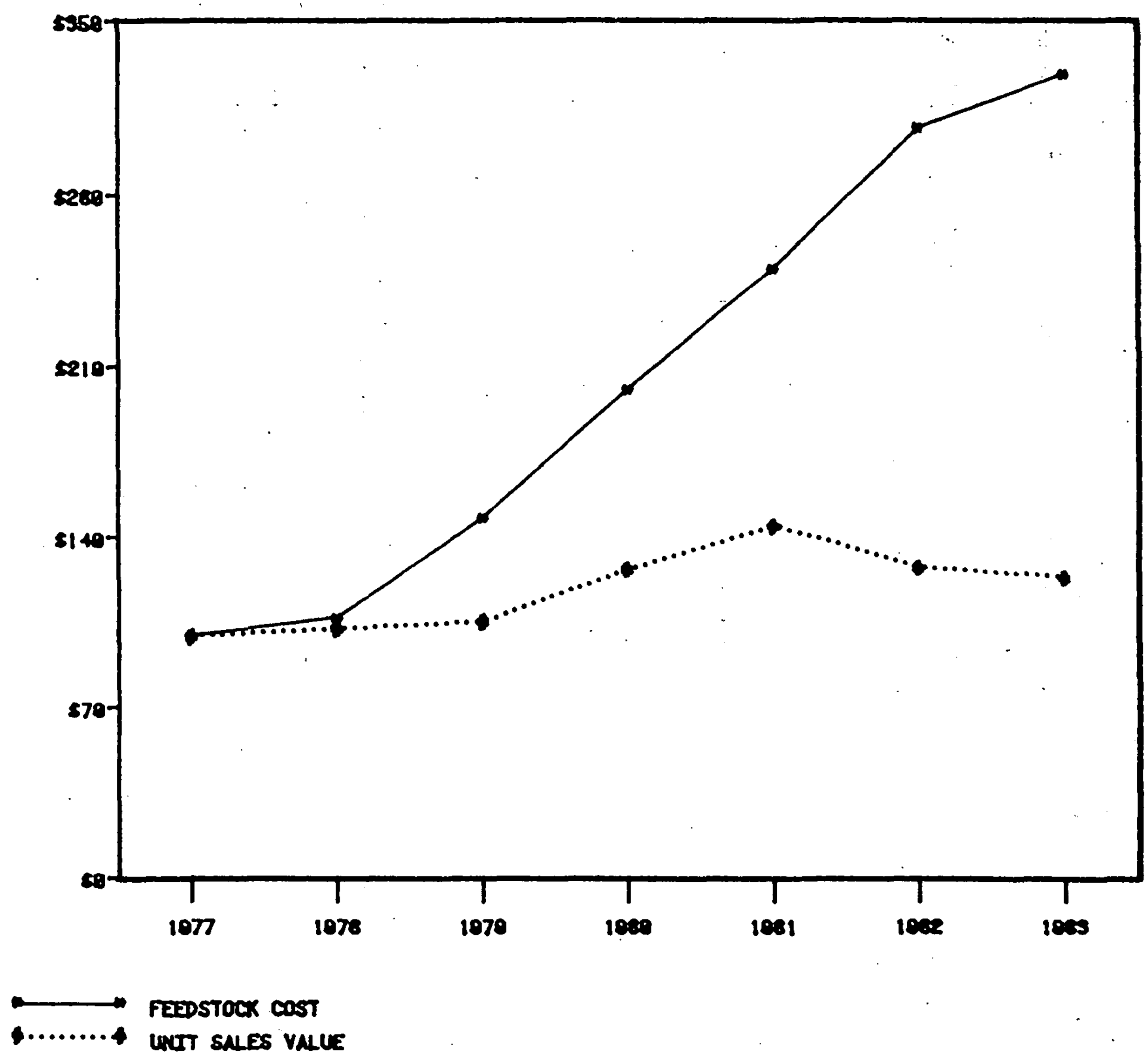
1/ The British Sulfur Corporation, World Fertilizer Atlas, 1983, and Food Agriculture Organization of the United Nations, FAO Fertilizer YearbooK, 1982, vol. 32.

2/ In addition to operating capacity as of Jan. 1.

3/ The British Sulfur Corporation, World Fertilizer Atlas, 1983

4/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional-Energy-Rich-Nations, USITC Publication No. 1370, April 1983, pp. 162-164.

FIGURE 6.—AMMONIA: FEEDSTOCK COST AND UNIT SALES VALUE INDEXES



The immediate status of the U.S. producers of ammonia shows a return to operating rates not reported since 1981 and increased demand for the domestic products. Average operating rates 1/ which had decreased from an industry high of 99 percent in 1981 to an industry low of 77 percent in 1983, 2/ recovered to approximately 98 percent for the period January-June 1984. 3/ Production data for January-June 1984 4/ indicate that during 1984, total production will remain below the record level of 19.7 million tons in 1980, but will exceed 16 million tons for the first time since 1981.

Specialty Chemicals

Specialty chemicals comprise a significant, though somewhat ambiguous sector of the U.S. chemical industry. We are examining, however, a more general move toward higher value-added chemical products (which we are calling specialty chemicals). The outward appearance of this trend has been dramatic, especially in the context of industry trade literature and discussions among industry analysts. 5/ The visibility of this trend was accentuated by two factors, the second crude petroleum price shock during 1979-80, and the plans for commodity petrochemical development in CERN's which began to reach fruition in the early 1980's.

At the present time, firms that once were only involved in the commodity side of the U.S. chemical industry are making every effort to become involved in the "specialty" chemicals business. 6/ These efforts, however, have usually been through acquisitions, joint ventures, and other business approaches, which have not involved the creation of new companies. 7/

A major contributing factor towards the strategic decision to use this approach to enter the specialty chemicals area is the total unfamiliarity that traditional commodity chemical producers have with the specialties market and production schemes. The major differences are highlighted in the following tabulation: 8/

1/ Percent of operative capacity; does not include inactive or permanently closed capacity.

2/ The Fertilizer Institute, Fertilizer Facts and Figures, 1984.

3/ The Fertilizer Institute, "Operating Rates Survey, January-June 1984."

4/ Ibid., and Chemical Engineering News, Jan. 30, 1984, p. 11.

5/ "Specialties on the Way Up," Chemical Marketing Reporter, Dec. 12, 1983, pp. 3 and 52, and "The Race Is On For Specialty Chemicals," CPI Purchasing, July 1984, pp. 45-59.

6/ "The Race Is On For Specialty Chemical," CPI Purchasing, July 1984, pp. 45-59.

7/ ECN Specialty Chemicals Supplement, October 1984, pp.4-7.

8/ Information taken from various industry published sources.

Category	Commodities	Specialties
Production characteristics:		
Volume-------------------------	Large	Small
Plants/facilities--------------	Costly, not able to vary product	Small, inexpensive, able to switch products
Operation----------------------	Continuous 24-hour operation	Batch, production as ordered
Business/Market characteristics:		
Technical requirements---------	Rely on engineering	Rely on chemical innovation
Labor requirements-------------	Minimal, rely on automation	Costly, rely on ideas, innovation
Costs--------------------------	Fixed costs more than 80 percent of sales	Marketing costs approximately 50 percent of sales
Return on investment-----------	Low	High
Competitive edge---------------	Process economics	Performance

Although these two sectors of the chemical industry are so dependent on each other for feedstocks and markets, until recently there was very little understanding between them concerning their operating structures. As the number of commodity petrochemical producers who became involved in the specialties business increased, the number of those commodity firms which realized they were not designed properly to manage a specialties business also increased. Many of these non-specialty oriented firms have promptly divested their purchases in an effort to avoid failures. 1/

Industry structure

The evolution of the specialty chemicals industry has been rapid, and sometimes, apparently without plan. However, the structure has evolved and has reached a stage where there is much competition between domestic specialties firms. The structure of these firms in many instances dictates the degree of the competition, as the major products are usually very recent technological innovations, or at the least, recently discovered applications.

Specialties producers must invest heavily in several areas, areas which are quite different from those carrying the greatest weight for the commodity petrochemical industry. One area in particular that needs specific concentration for the specialties manufacturer is Research & Development

1/ "The Trend Toward Specialty Chemicals," Chemical Engineering Progress, October 1984, pp. 11-15.

(R. & D.). 1/ For a specialties manufacturer to be successful, he cannot find one product and feel secure that a permanent market has been achieved. As all specialties are sold on a performance basis, constant product development and refinement must be taking place. This constant change in the industry needs to be taken advantage of, and not many traditional commodity petrochemical companies have management or R. & D. departments structured so that the firms are able to fully utilize the opportunities given by this changing market. 2/

In many cases, product development in a specialty chemical companies' R. & D. laboratory could transpire totally within the space of one afternoon. The management of these firms needs to develop a structure in which their marketing representatives have intimate and immediate contact with the R. & D. staff. This contact is necessary to maintain an imperative speed of response to commercial opportunities. 3/

The necessary immediacy of response is just one of the pressures that must be dealt with in the structural organization of a specialty chemical company. Other concerns are more familiar to a traditional commodity petrochemical producer, such as securing a stable market position, sustaining a proprietary position, building sales volume while lowering costs, and recognizing and serving their market needs. 4/ However, these concerns must be addressed in a different, and necessarily much faster manner than the structure of commodity petrochemical producers would tend to allow. The strict segmentation of operating divisions in most traditional commodity petrochemical firms acts as a prohibitive force toward instant response to specialty chemical market forces. 5/

The accent on a competent, technologically trained sales force is also a major factor in successful specialty chemical-oriented firms. Many buyers of these products make their purchase decisions based not only on whether the product in question can do the job, but also on the service offered by the specialty chemical firm. Often the most important contact point between the specialty chemical firm and the buyer is the sales representative. The technology-literate sales representative who is able to answer technical questions and provide more than references to technical experts in the company has a clear advantage when compared with another sales representative without the technical expertise. 6/ In the case of major accounts, teams which include technical or R. & D. experts are often used. The costs, therefore, to these specialty chemical firms for their sales/marketing organizations are approximately five times the sales costs for a commodity petrochemicals business. 7/

1/ "The Trend Toward Specialty Chemicals," Chemical Engineering Progress, October 1984, pp. 11-15.

2/ Ibid.

3/ Ibid., p. 14.

4/ "Chemical Specialties", presented at the conference on Strategic Planning for Petrochemicals, sponsored by the Energy Bureau, Sept. 11, 1984.

5/ "Specialty Chemicals Push Raises New Managment Problems," Chemical & Engineering News, Aug. 1, 1983, pp. 8-10.

6/ "Bringing Specialties into Sales Focus," Chemical Business, November 1984, pp. 59-62.

7/ Ibid.

Although traditional marketing functions and expenses are similar, they need to be employed differently in specialty firms. The target of sales for the firm producing chemical specialties is clearly distinct from the sales target of the commodity petrochemical firm. Chemical specialties are, according to a major U.S. producer, purchased by design engineers as opposed to purchasing agents who usually negotiate contracts for commodities. 1/ This narrow consumer audience allows for a more focused, direct marketing approach, and therefore a structure which promotes such relationships is considered highly beneficial.

A positive aspect of a commodity petrochemicals company having a specialty chemical company as a subsidiary, is the guaranteed source of feedstock materials, usually commodity petrochemical intermediates. Those acquisitions of specialty chemical firms by larger commodity petrochemicals producers which have proven the most successful are those in which the commodity petrochemical producer manufactures the particular feedstocks needed by the specialty firm. 2/

Competitive status

The current competitive position of U.S. specialty chemical producers vis-a-vis foreign competition is very strong. A recent British study of the Western European specialty chemicals market indicated that in 1983, the specialty chemicals market in the United States accounted for approximately 46 percent of the sales of specialty chemicals throughout the free world. 3/ The Western European market was found to account for 34 percent and the Japanese market 15 percent of specialty chemical sales. 4/ The anticipated growth in domestic demand for specialty chemicals is expected to bring about an even more improved market situation for the domestic industry. This is related to the fact that domestic demand has generally been satisfied by domestic producers, and they are expected to remain the major suppliers to the domestic industry at least through 1990. 5/

The U.S. domestic market for specialty chemicals appears to be growing at a much faster rate than the overall economy. The average growth rate anticipated for the specialty chemicals industry in the United States is approximately 5 percent per annum during 1983-90. 6/ The following tabulation shows the estimated value of U.S. domestic sales of selected specialty chemicals industry segments for 1983 (in millions of dollars), along with growth rates for these segments as predicted by a domestic industry analyst (in percent): 7/

1/ Ibid., p. 61
2/ "Specialty Chemicals Push Raises New Management Problems," Chemical & Engineering News, Aug. 1, 1983, pp. 8-10.
3/ "Demand for Specialties Will Increase Pace," European Chemical News, Sept. 10, 1984, p. 12.
4/ Ibid.
5/ "Specialty Chemicals: Mixed Bag for Growth," Chemical and Engineering News, June 4, 1984, pp. 20-23.
6/ Ibid, p. 20.
7/ Ibid.

Segment	U.S. sales 1983	1983-90 Annual growth rate
Oilfield chemicals-------	4,200	7
Electronics chemicals----	2,500	13
Specialty polymers-------	1,800	9
Diagnostics--------------	1,500	10
Catalysts----------------	1,200	5

Twenty-five other segments of the specialty chemicals area have also been identified; those listed in the previous tabulation are either very high growth areas (electronics chemicals, diagnostics, and specialty polymers) or fields which are particularly related to improving productivity for producers of commodity petrochemicals. Both oilfield chemicals, which have the potential to improve the feedstock availability situation through enhanced oil recovery (EOR) techniques, and catalysts, which may improve production processes, are segments to which significant interest is being paid by major producers of commodity petrochemicals. The potential for technological advantages provides one of the only avenues remaining for increasing the profitability of the commodity petrochemical industry.

Oilfield chemicals

The specialty chemicals sector known as oilfield chemicals contains certain commodity chemicals applied as specialties, as well as blends of special lubricants, corrosion inhibitors, surfactants, and other chemicals developed for unique uses. These oilfield specialty chemicals are used for many purposes in drilling and EOR operations. By function, the sector can be divided into drilling chemicals, completion and workover chemicals, cementing chemicals, stimulation chemicals, and production chemicals. 1/ The largest proportion of specialty chemicals are used in the production segment. 2/

The following tabulation shows the assortment of chemicals needed to fulfill certain functions during production: 3/

1/ "Specialty Chemicals for Oilfield Applications," Symposium of the Chemical Marketing and Economics Division of the American Chemical Society, Apr. 10-12, 1984, pp. 69-87.
2/ Ibid., p. 72.
3/ Ibid., p. 85.

Use	Chemicals
Emulsion breakers----------	EO/PO resins, alkyl aryl sulfonates.
Defoamers------------------	Silicones
Corrosion inhibitors-------	Amido-amine/imidazoline, ethoxylated amines.
Bactericides---------------	Fatty amines, quaternary ammonium compounds, glutaraldehyde.
Scale inhibitors-----------	Phosphonates, phosphate esters, polyacrylates.
Paraffin control-----------	Xylene, toluene, ethoxylated nonyl phenol, ethylene vinyl acetate copolymers.

Demand for oilfield chemicals depends directly on the demand for crude petroleum. 1/ The oilfield chemicals market grew at a rate of about 21 percent per year during 1978-82, and the value of sales of these specialty chemicals increased from $2.6 billion to $5.5 billion during that period. In 1983, the U.S. companies involved in the oilfield specialty chemicals services business averaged operating income losses of around 92 percent compared with 1982 operating income. 2/ Losses were the direct result of decreased petroleum demand. 3/

The producers of oilfield specialty chemicals are predominantly service companies which procure materials from either chemical firms or wholesalers and blend their own proprietary products. Entry into this specialty chemical market is not easy. The established service companies have developed excellent working relationships with oil companies, and their customers are very reluctant to change. Chemical companies trying to sell oilfield specialty products directly to the specialty service companies have met with very limited success. Only three U.S. petroleum companies have started subsidiaries to serve their own field operations. These subsidiary companies do not sell or service other oil companies since, traditionally, oil companies do not buy from competitors. 4/

Growth for this area of specialty chemicals is expected to increase as the need for crude petroleum and natural gas increases. Future growth rates of from 5 to 10 percent per year are predicted, 5/ as the use of EOR techniques expands in direct proportion to the depletion of easily accessible crude petroleum deposits. 6/

1/ Ibid.
2/ Ibid., p. 68.
3/ Ibid., p. 69.
4/ Ibid, pp. 86-87.
5/ Ibid., p. 74.
6/ "Specialty Chemicals in an Era of High Technology," The Chemical Industry: An Emerging Phoenix, May 7-10, 1984, the Chemical Marketing Research Association.

Electronics chemicals

Applied research in the development of certain special technologies and the associated specialty chemicals has enabled integrated circuit manufacturers to reach levels of miniaturization which made possible such commonly accepted but diversified items as wrist televisions, portable computers, and implantable human heart pacemakers. Integrated circuits, which are multilayered packages of tiny transistors and their connections linked together to produce a device capable of performing a specific end function or broad range of functions, require very sophisticated ultrapure specialty chemicals for their manufacturing process. These specialty chemicals are used in producing the substrates on which the etched circuits are made, the protective coatings, the precious metal electrical connections, and the surface sensitizers, chemicals which behave like those in photographic emulsions. There are approximately 250 manufacturing plants for semiconductors worldwide; 1/ the largest of these plants are owned by the multinational firms which traditionally have been considered as producers of consumer end-product electronic devices. 2/ The raw materials and specialty chemicals consumed in producing these semiconductors are obtained, for the most part, from three principal sources: multinational chemical firms with both commodity and specialty chemical operations, small producers of specialty chemicals; and, in certain instances, semiconducter manufacturing firms which have integrated back through their corporate structure to subsidiary chemical companies. 3/ The following tabulation shows worldwide demand for electronic chemicals in 1983 (in millions of dollars): 4/

Area	Demand	Percent of total
United States	2,600	45
Japan	1,700	30
Western Europe	800	14
Other	600	10
Total	5,700	100

Growth in electronics chemicals is projected to be around 13 percent per year until 1990, but certain areas (niches) are expected to perform even better, as shown in the following tabulation (in percent): 5/

Niche	Average annual increase 1983-90
Plasma processing materials	40
Materials for photovoltaic cells	40
Conformal coatings	20
Conductive coatings	20
Photovoltaic chemicals	40

1/ "Technical Challenge in Electronic Chemicals," European Chemical News, October 1984, pp. 15-17.

2/ Ibid, p. 16.

3/ Ibid, p. 15.

4/ Ibid.

5/ "Review and Forcast for Specialty Chemicals - The Strong Performance will Continue," The Chemical Industry: An Emerging Phoenix, May 7-10, 1984, The Chemical Marketing Research Association, p. 68.

The actual rate of growth for certain niches in the area of electronic chemicals will depend on the success of applied research currently being conducted within the industry. Specific advances are expected to be made in the sectors listed below: 1/

Current product	Replacement	Likely benefits
Silicon substrates	Gallium arsenide	Faster switching speeds.
Positive photoresists	X-ray resists Electron-beam resists.	More precise semi-conductors.
Various wet chemicals	Plasma gases	Better etching
Laminated PCB's	Injection molded PCB's.	Three dimensional designs.

The major markets for electronic chemicals are expected by industry analysts to remain the United States, Japan, 2/ and Western Europe. 3/ These three sophisticated markets are expected to show an average growth rate of from 6.5 to 13 percent per year until 1990. These world areas are also home for the specialty chemicals producers who will meet this demand. Although competition will become more intense, the electronics chemicals area is expected to be sufficiently large to accomodate the established and emerging firms up to 1990. 4/

Specialty polymers

The specialty polymers or engineering plastics are products with high ratings for mechanical strength, chemical resistance, high temperature tolerance, and good electrical properties. The major markets for these specialty chemicals are in the transportation, electronics, appliances, and construction industries. These polymers are used in place of metal and must function accordingly during prolonged usage. The following tabulation lists some specialty polymers and their physical properties. 5/

1/ Specialty Chemicals in an Era of High Technology," The Chemical Industry: An Emerging Phoenix, The Chemical Marketing Research Association, May 7-10, 1984, p. 195.

2/ "Key Questions Posed as Investors Look to Specialty Chemicals," European Chemical News, Aug. 20/27, 1984, p. 14.

3/ "Demand for Specialties will Increase Pace," European Chemical News, Sept. 10, 1984, p. 12.

4/ "Specialty Chemicals: Mixed Bag for Growth," Chemical & Engineering News, Jun. 4, 1984, pp. 20-22.

5/ Kline Guide to the Plastics Industry, Second Edition, Charles H. Kline and Co., Inc., Fairfield, N.J. 07006.

Polymer	Impact	Strength	Electrical	Chemical	Thermal
Polycarbonate-----	Very high	High	Good	Fair	Good
Nylon--------------	Good	Very high	Very good	Good	Good
Polyphenylene oxide-styrene---	High	High	Good	Excellent	Good
Polyacetal---------	Good	High	Excellent	Good	Good
Polybutylene terephthalate---	Good	Excellent	Very good	Good	Good
Polysulfone--------	Very good	Very good	Very good	Excellent	Excellent
Fluoropolymers-----	Very good	Poor	Excellent	Excellent	Excellent

Producers of specialty polymers include the traditional manufacturers of plastics resins plus some captive producers. Approximately 265 U.S. producers of plastics resins were estimated to be active in 1982. U.S. sales of specialty polymers in 1983 was $1.8 billion, approximately 4 percent of total specialty chemical sales; 1/ a growth rate of 9 percent per year is expected until 1990 for this segment. 2/ Production of engineering resins in 1983 was 731 million pounds.

The reason for growth in this specialty chemicals area is the lower cost of a given specialty plastic compared with an equivalent amount of metal. The following tabulation highlights such comparisons between the cost of specialty plastics and that of the metals they are replacing (in cents per cubic inch): 3/

1/ "Specialty Chemicals: Mixed Bag for Growth," Chemical and Engineering News, Jun. 4, 1984, p. 20.
2/ Ibid.
3/ Chemical Business, May 1984, p. 41.

Item	Price
Plastics:	
Acetal	7.6
Nylon 6/6	7.5
Polycarbonate	7.2
Polybutylene terephthalate (PBT)	6.7-8.0
Modified polyphenylene oxide (MPPO)	5.1-9.1
Mineral-reinforced nylon	7.2
Glass-reinforced polyethylene terephthalate (PET)	8.0
Glass-reinforced nylon	8.9
Glass-reinforced polycarbonate	11.3-11.7
Glass-reinforced PBT	8.8-11.3
Glass reinforced MPPO	8.3-9.1
Metals:	
Magnesium ingot AZ63A	9.3
Aluminum SAE 309 (380) ingot	8.4
Zinc SAE 103 ingot	11.6-12.8
Brass yellow ingot	22.7
Steel cold-rolled carbon sheet	7.0
Steel hot-rolled sheet	5.9

By replacing metal with lightweight plastics, the transportation industry has been able to reduce vehicle weight and increase fuel economy while maintaining passenger safety. 1/ Producers of specialty resins need only vary formulations and add small amounts of modifiers in order to develop new products. This eliminates the need to invest in new equipment whenever a new specialty plastic with certain performance requirements is needed, and also minimizes the time period for development and full-scale production of innovations. 2/ The simplicity of blending specialty resins, while a distinct advantage in terms of producer costs, makes competition extremely strong. 3/

The market for specialty polymers, such as engineering thermoplastic resins, is expected to be mostly in the industrialized nations. However, for certain end-products used for common consumer items, the market can be worldwide, as seen in of the following tabulation: 4/

1/ "How Polymer Alloys Give Plastics a Bigger Reach," Chemical Business, May 1984, p. 40.

2/ Ibid., p. 41.

3/ "This Year You'll See More Than 100 New Engineering Thermoplastics . . . and Nobody Should Have to Ask Why?," Modern Plastics, January 1984., p. 51.

4/ Facts & Figures of the U.S. Plastics Industry, 1984 edition, The Society of the Plastics Industry, Inc., September 1984.

Polymer	Typical applications
Acetal (AC)	Sinks, faucets, electrical switches, gears, aerosol bottle, meat hooks, lawn sprinkers, ballcocks, shaver cartridges, zippers, telephone pushbuttons.
Polycarbonate (PCO)	Helmets, power tool housings, battery cases, safety glass, auto lenses, 5 gal. bottles.
Polyphenylene sulfide (PPS)	Electrical connectors, coil forms, lamp housings.
Thermoplastic polyester (TP)	Electrical bobbins, TV tuners, fuse bearings, cams, auto ignition coil caps, speedometer frames, pump impellers and housings.
Polysulfone (PSO)	Electrical connectors, meter housings, coffee-makers, camera bodies, auto switch and relay bases, light-fixture sockets, fuel cell components, battery cases.
Modified polyphenylene oxide (PPO)	Auto dashboards, pumps, shower heads, plated auto grilles and trim, appliance housings, wiring splice devices, protective shields.
Polyimide (PI)	Radomes, printed circuit boards, turbine blades.
Polyamide-imide (PAI)	Valves, gears, pumps, high temperature magnet wire enamels.

Diagnostic chemicals

Diagnostic chemicals constitute a wide group of chemicals produced synthetically and biologically, which are used to measure or detect alterations in normal human body chemistry caused by a disease process or levels of administered pharmaceuticals. Growth during the past several years has been between 15 and 20 percent per year. 1/ This segment of the specialty chemicals area is expected to have an average annual growth rate of 10 percent per year through 1990. 2/ At present, the worldwide market for diagnostic products is approaching $4.5 billion. 3/ The U.S. market accounts for about 44 percent of the world market, and is valued at approximately $2 billion.

Presently there are about 100 producers of diagnostic chemicals. The producers are predominantly major health care firms, with a few diversified multinational chemical firms and smaller biotechnology companies trying to develop special sections of the diagnostics area. 4/

1/ "Medical Diagnostics: A Red-Hot Market for Chemicals and Hardware," Chemical Week, Feb. 29, 1984, pp. 30-35.
2/ "Specialty Chemicals: Mixed Bag for Growth," June 4, 1984, p. 20.
3/ Ibid.
4/ Ibid.

The most promising niches for growth in diagnostic specialty chemicals are expected to be in the marketing of both reagents and associated instruments as a package, and in monoclonal antibody tests developed through genetic engineering technology. 1/ The rapidity and specificity of monoclonal antibody radio-immunoassay procedures make these tests rank high as competitors to the older wet chemical methods. The following tabulation shows certain tests which lend themselves to monoclonal antibody technology: 2/

Test	Relative advantage
Pregnancy	99 percent accuracy using monoclonal antibody technology. Expensive instrumentation not needed.
Hepatitis B	Substantially larger number of carriers detected with monoclonal antibody technique.
Prostate cancer	Simplifies diagnosis. Earlier detection through higher sensitivity.
White blood cells	Early dectection of immune system disorders such as leukemia and acquired immune deficiency syndrome (AIDS).

The market for diagnostic chemicals, as illustrated in the following tabulation, is presently dominated by large clinical laboratories normally associated with hospital centers, but important future markets are expected to be sales to medical doctors for use in their offices and over-the-counter sales to the general public. 3/ The tabulation shows sales of specialty diagnostic chemicals to domestic markets in 1983 (in millions of dollars). 4/

Market	Sales
Clinical laboratories	$1,858
Physicians' offices	227
Homes	210
Total	1/ $2,295

1/ Includes diabetic ($36 million) and pregnancy ($30 million) test reagents, blood-pressure devices ($121 million) of which $49 million are electronic in nature.

U.S. producers are considered the leaders in the technologies needed for this specialties area, but some Western European and Japanese firms are also making bids to enter the sector. 5/

1/ Ibid.
2/ Business Week, Apr. 11, 1983.
3/ "Medical Diagnostics: A Red-Hot Market for Chemicals and Hardware," Chemical Week, Feb. 29, 1984, p. 31.
4/ Ibid., p. 30.
5/ Ibid., p. 31.

Catalysts

A catalyst is a chemical used to reduce the amount of time and energy needed in producing other chemicals. The catalyst is not consumed during the reaction process, but may lose all or part of its effectiveness by interacting (surface poisoning) with byproducts or contaminating chemicals during the reaction. As an area of specialty chemicals, catalysts are considered to be a mature market, hence growth rate is not expected to be as dynamic as with other specialty chemicals. The anticipated average annual growth rate 1/ between 1983-90 is estimated at 5 percent, with consumption expected to be distributed in various industries and for the purposes shown in the following tabulation (in millions of dollars): 2/

	1982	1987
Petroleum refining industry	510	620
Catalytic cracking	235	330
Alkylation	150	170
Hydrotreating	65	85
Hydrocracking	40	45
Catalytic reforming	20	20
Chemical process industries	465	570
Polymerization	215	270
Organic synthesis	80	95
Oxidation, ammoxidation, and oxychlorination	75	90
Hydrogen, ammonia, and methanol synthesis	50	60
Hydrogenation	35	42
Dehydrogenation	10	13
Emission control industry	333	297
Automotive	330	285
Industrial	3	12
Total	1,308	1,487

1/ "Specialty Chemicals: Mixed Bag for Growth," Chemial and Engineering News, June 4, 1984, p. 20.

2/ "Catalysts: A Chemical Market Poised for Growth," Chemical and Engineering News, Sept. 5, 1984, pp. 27-31.

Producers of catalysts are major multinational chemical firms which can afford the research and development efforts necessary to prove the onstream advantages of new catalytic processes. 1/ In many cases, the firm not only develops the specific catalyst, but also the overall technology 2/ for a given product and markets both as a package. 3/

Total U.S. sales of catalysts in 1983 were $1.2 billion, representing around 2.7 percent of all U.S. specialty chemicals sales. 4/ Worldwide sales of catalysts and catalytic processes are expected to be greater than $2.7 billion in 1984, with petroleum uses accounting for 35.2 percent of the total and chemical uses accounting for 49 percent. 5/

Although the area of catalysts is considered to be a mature market overall, there are still opportunities for progressive, innovative companies to make good profits. 6/ One niche, hydrotreating catalysts, is expected to grow at a 10 percent-per-year rate until 1990. 7/ Catalysts have universal applications in industrial process chemistry.

Some common uses include production of plastics resins, ammonia, methanol, and other major commodity petrochemicals; and major intermediate products, such as ethylene oxide, ethylene dichloride, and ethylbenzene. 8/ Table 9 details a number of explicit relationships between products and the associated specialty chemical catalyst.

The market for catalysts is shifting from the industrialized nations to the industrially developing nations, as the world commodity petrochemical production shifts to these nations, also. 9/ The U.S. market was about 54 percent of the total world market in 1975, but may only be 45 percent by 1990. 10/ Europe was 22 percent of the 1975 catalyst market but is expected to represent only 21 percent by 1990. 11/

1/ "Research Sets the Pace for Tomorrow's Technology," Chemical Business, September 1984, pp. 27-31.
2/ Ibid., p. 30.
3/ "Polyethylene process focus of BP licensing effort," Chemical and Engineering News, Nov. 19, 1984, p. 40.
4/ "Specialty Chemicals: Mixed Bag for Growth," Chemical and Engineering News, June 4, 1984, p. 20.
5/ "Catalysts Sales Worldwide Seen Rising by 8.8 Percent a Year," Chemical Marketing Reporter, Nov. 12, 1984, p. 3.
6/ Ibid.
7/ "Specialty Chemicals: Mixed Bag for Growth," Chemical and Engineering News, June 4, 1984, p. 20.
8/ "Catalysts: A Chemical Market Poised for Growth," Chemical and Engineering News, Dec. 5, 1984, p. 22.
9/ "Catalyst Sales Worldwide Seen Rising by 8.8 Percent a Year," Chemical Marketing Reporter, Nov. 12, 1984, p. 3.
10/ Ibid.
11/ Ibid.

Table 9.--Catalysts: Industrial process users and associated products

Selected process	Products
Polymerization:	
Ethylene, propylene	High-density polyethylene, polypropylene.
Ethylene, vinyl chloride, styrene	Low-density polyethylene, polyvinyl chloride, polystyrene.
Synthesis gas:	
Steam hydrocarbon reforming	Hydrogen and carbon monoxide.
Ammonia synthesis	Ammonia
Methanol synthesis	Methanol
Olefins	Aldehydes
Acetic acid	Acetic anhydride
Alkylation:	
Benzene	Cumene
Benzene	Detergent alkylates
Benzene	Ethylbenzene
Hydrogenation:	
Benzene	Cyclohexane
Dehydrogenation:	
Butane	Butadiene
Butene	Butadiene
Ethylbenzene	Styrene
Petroleum hydrocarbons	Benzene, toluene, and xylenes
Oxidation:	
Ammonia	Nitric acid
Ethylene	Ethylene oxide
Methanol	Formaldehyde
Propylene	Propylene oxide
Sulfur dioxide	Sulfur trioxide
Ammoxidation:	
Methane	Hydrogen cyanide
Propylane	Acrylonitrile
Oxychlorination:	
Ethylene	Ethylene dichloride

Source: "Specialty Chemicals: Mixed Bag for Growth," Chemical and Engineering News, June 4, 1984, p. 20.

WORLD PETROCHEMICAL INDUSTRY DEVELOPMENT

The full effects of the 1973-74 OPEC embargo and subsequent price increases for crude petroleum triggered by the 1979 Iranian crisis were not transposed into the economic situation of the world petrochemical industry until around 1980, as most cost increases for the producers were passed directly to consumers of the products with relatively small negative market reactions during the 1970's.

The combination of lowered demand for products of crude petroleum and higher petroleum prices had a more immediate impact on those industrial nations which were totally without a domestic supply of crude materials. 1/ Western Europe and Japan were impacted to a greater extent by the first crude petroleum price shock than was the United States. 2/ The decisions necessary to be made throughout the world's petrochemical industry were to what extent commodity petrochemical capacity needed to be rationalized in order to remain competitive. These plant closures, streamlining, and modernizations would be expected to reestablish the industry on a firmer base. 3/

As rationalization proceeded, the OPEC nations began feeling the combined effects of reduced income from diminished crude petroleum sales from declining demand and the loss of a sizeable proportion of the world crude petroleum market to non-OPEC producers. In order to diversify their base of production, they sought to integrate downstream into production of commodity petrochemicals. 4/ Through joint venture agreements with multinational corporations, massive worldscale plants were planned to produce ethylene, ammonia, and methanol from natural gas normally flared during production of crude petroleum. This decision to enter areas of the downstream market by using readily available and comparatively inexpensive feedstocks signaled to present world-scale producers of these same products that further restructuring was essential if their industries were to remain viable. 5/ The combined circumstances of exaggerated raw material costs, increasing inflation, and the future presence of CERN's as commodity petrochemical producers have set the scenario 6/ for industrialized nations to consider alternate strategies.

1/ "Petrochemicals: The Future Means Change," Hydrocarbon Processing, November 1983, pp. 23-25.

2/ Ibid.

3/ "NPRA Offers a U.S. View on Petrochemicals," Manufacturing Chemist, May 1983, pp. 45-47, and "Restructuring," Chemical Week, Oct. 26, 1983, pp. 26-28.

4/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983, pp. 37-140.

5/ "NPRA Offers a U.S. View on Petrochemicals," Manufacturing Chemist, May 1983, pp. 45-47, and "Restructuring," Chemical Week, Oct. 26, 1983, pp. 26-28.

6/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983.

Traditional Commodity Petrochemical Producers

Western Europe

The traditional major suppliers of basic commodity petrochemicals in Western Europe are France, Italy, Spain, West Germany, the Netherlands, and the United Kingdom. With the discovery of the large petroleum and natural gas reserves in the North Sea, the Scandinavian countries have also become major producers of the same basic commodities. 1/

Basis for development

Western Europe, along with Japan and the United States, has a sophisticated market for petrochemicals. But, like Japan, Western Europe lacks the natural resources to be totally independent in feedstocks. Hence, as a direct result of the two major crude petroleum crises of the 1970's, changes have had to be made in Western Europe's industrial structure. 1/

According to a briefing paper from the Briefing Services of the British Government, Western Europe is still very dependent on imported energy sources. 2/ The report states that 70 percent of Western European net petroleum consumption, 17 percent of its natural gas consumption, and 20 percent of its coal consumption in 1983 needed to be imported. About 40 percent of the imported crude petroleum was from the Middle East.

Western European petrochemical production is based primarily on petroleum-derived heavy liquids feedstocks. Although some facilities are capable of utilizing both natural gas liquids or naphtha (a petroleum-derived feedstock), the necessity to import these materials leaves Europe in an unfavorable competitive situation when compared with the Middle Eastern natural gas-based industries. 3/

Current competitive status

The new production facilities in the CERN's, plus overcapacity in basic commodity petrochemicals throughout the world, demanded that the West European industry close certain plants. 4/ Between 1979 and 1983, 2.7 million metric tons per year of ethylene cracker facilities were closed in Western Europe. The facilities closed are shown in the following tabulation (in thousands of metric tons-per-year). 5/

1/ "Recovery Is Underway but Overcapacity Remains a Problem," Chemical & Engineering News, Dec. 19, 1983, pp. 32-36.

2/ "European Petrochemical Producers Face More Modest Growth," Chemical & Engineering News, Nov. 5, 1984, pp. 15 and 16.

3/ August 1984 briefing paper, Briefing Services, Government and Public Affairs Department, Britannia House, Moor Lane, London, EC2Y9BU, England.

4/ "Call for Unity Against Impending Gulf Imports," Manufacturing Chemist, July 1984, p. 7.

5/ "Chop Chop Europe," Manufacturing Chemist, August 1983, pp. 38-41.

Country	Capacity	Year closed
Italy	60	1979
West Germany	100	1979
West Germany	100	1979
United Kingdom	250	1980
United Kingdom	90	1980
West Germany	70	1981
West Germany	360	1981
West Germany	150	1981
Spain	50	1981
Italy	90	1981
Italy	65	1981
Austria	150	1981
France	95	1981
Netherlands	135	1981
Netherlands	300	1982
United Kingdom	250	1982
Spain	70	1982
West Germany	320	1982
France	-	1983

The European Commission in Brussels stated that the overall plant closures related to the existing overcapacity in basic commodity petrochemicals would probably result in 4,000 direct job losses and an additional 10,000 jobs lost indirectly. Even though Western Europe has shut down 21 percent of its ethylene capacity, 19 percent of its low-density polyethylene capacity, 17 percent of its polystyrene capacity, and 12 percent of its polyvinyl chloride capacity since 1980, many industry experts recommend that further cuts are needed. 1/

The greatest proportions of the closures already seen in Western Europe have been in West Germany and the United Kingdom, where the petrochemical industries are privately owned. Italian and French industries face more political constraints to closings since a larger proportion is state owned.

West Germany.--As the West German market is one of the most sophisticated in Western Europe and leads in demand for commodity petrochemicals, its economic status is a good indicator of the status of the Western European economy. During the first-half of 1984, West German chemical exports accounted for 50 percent of total sales, 2/ a 5 percent increase over 1983. 3/ Despite concerns that more rationalization measures must be taken to ensure long-term competitive viability, 1983 was a year of increased output, sales turnover, and sales volume for the West German chemical industry. 4/ The 7 percent increase overall brought the industry back to the prerecession level of 1979.

1/ Ibid.

2/ "West German Chemical Exports to U.S. Jump by Over 50 Percent," European Chemical News, July 16/23, 1984, p. 13.

3/ "German Chemicals Growth Peaked in Summer," European Chemical News, Oct. 22, 1984, p. 6.

4/ Chemische Industrie, Apr. 2, 1984, p. 236.

West Germany alone accounts for about 7.2 percent of the world chemical market. The industry has around 1,900 companies employing 550,000 workers. West Germany's 1983 olefin capacity, production, and consumption are shown in the following tabulation (in thousands of metric tons): 1/

Product	Production	Consumption	Annual capacity	Capacity utilization
				Percent
Ethylene	3,181	2,913	3,940	81
Propylene	1,740	2,197	2,236	78
Butadiene	528	279	542	97
Total	5,449	5,389	6,718	81

West German olefin capacity is approximately 30 percent of the European Community's total, although foreign markets usually account for 40 percent of the industry's sales. Imports generally account for around 34 percent of West German domestic demand. 2/

The West German industry has traditionally been a leader in technology improvement through research. As a member of the board of management of a major West German multinational chemical firm stated, even during poor years, the German industry invests 5 percent of its sales income into R. & D. 3/

The industry is still based primarily on naphtha feedstocks. West Germany does, however, use about 155 trillion cubic feet per year of natural gas for feedstock. 4/ This represents approximately 15 percent of their annual feedstock requirements. Around 17 percent of this requirement for natural gas was purchased from the U.S.S.R. in 1982. The remainder was imported from the Netherlands and Norway. 5/

The West German petrochemical commodities industry has already made significant reductions in capacity. Most producers have historically been closely associated with the specialties chemical market, especially pharmaceuticals and fine chemicals. With the prospects for basic commodities production more economically feasible in the energy-rich nations, the West German industry will probably regroup its efforts in the more lucrative specialties sectors. 6/

1/ Chimie Actualities, Sept. 17, 1984, p. 5.
2/ "Europe Not Lagging - Hoechst Chief," European Chemical News, Oct. 22, 1984, p. 15.
3/ Ibid.
4/ "Soviet Gas Pipeline to Europe Starts Up," Chemical & Engineering News, Jan. 30, 1984, p. 18.
5/ Ibid.
6/ "Europe Not Lagging - Hoechst Chief," European Chemical News, Oct. 22, 1984, p. 15.

France.--The French petrochemical industry has been reticent to follow the lead of other Western European producers in terms of rationalization. Of Western European ethylene capacity presently shut down, France accounts for only 4.7 million metric tons out of a total of 18.3 million metric tons. France has contributed only 18 percent to the closures while maintaining 20 percent of the present Western European capacity. 1/ The French industry has not been able to follow cuts made by other European countries because of the controls imposed by the French Government. 2/

In 1983, the petrochemical industry underwent a major restructuring process directed by the French Government. 3/ Price controls, which were in effect in an effort to control a 9.3 percent inflation rate, 4/ and unemployment, which in 1983 was approximately 9.9 percent, together influenced the Government to redistribute petrochemical operations rather than undertake an aggressive plant closure program. The apparent outcome is an industry divided between three major producers rather than the five firms in existence prior to restructuring. 5/ The 1983 olefin output, capacity, and consumption figures are shown in the following tabulation (in thousands of metric tons): 6/

Product	Production	Consumption	Annual capacity	Rate of capacity utilization
				Percent
Ethylene	2,074	1,889	2,560	81
Propylene	1,115	1,009	1,455	77
Butadiene	282	421	330	86
Total	3,471	3,319	4,345	80

Although the industry appears to be doing well in terms of capacity utilization, domestic price controls have made it more profitable to export the majority of the output than market it domestically. French domestic prices were controlled as much as 20 percent lower than European averages, so that no profit could be made by supplying only domestic demand. 7/

1/ "French Chemical Industry Completes Massive Restructuring," Chemical & Engineering News, Apr. 2, 1984, pp. 22-25.
2/ Ibid.
3/ Ibid.
4/ "France, Strong Dollar Diminishes U.S. Sales Opportunities," Business America, Aug. 20, 1984, p. 10.
5/ "French Chemical Industry Completes Massive Restructuring," Chemical & Engineering News, Apr. 2, 1984, pp. 22-25.
6/ Chimie Actualities, Sept. 17, 1984, p. 5.
7/ "France, Strong Dollar Diminishes U.S. Sales Opportunities," Business America, Aug. 20, 1984, p. 10.

As the restructuring of the French chemical industry is approaching completion, the industry has announced plans to petition the Government for permission to close outmoded plants and lay off workers. The industries now hope to concentrate on making their market shares profitable by emphasizing their strengths and eliminating their weaknesses. 1/ The weakest link, presently is reported to be the fertilizers area, as natural gas feedstock prices are high and international market competition has been heavily in favor of the energy-rich nations. 2/

The French are also concerned with the growing industrial strength of Middle East chemicals, but feel that their own restructuring moves are beginning to become evident through such signs as healthier profit margins. 3/

United Kingdom.--The United Kingdom's (U.K.) domestic petrochemical industries have accounted for the largest share of Western Europe's capacity reductions. Also appreciation of British currency in the second half of 1979 relative to other European currencies triggered a decline in profits 2 years prior to the 1982 worldwide recession. 4/ This demanded that the British industry begin cost-cutting and rationalization measures long before the rest of Western Europe had even studied the extent of the overcapacity problem in basic petrochemicals. These early capacity reductions have proved beneficial to the U.K. producers, as output for the industry was up sharply in the first half of 1983. 5/ Olefin production for 1983 is shown in the following tabulations (in thousands of metric tons): 6/

Product	Production	Consumption	Annual capacity	Rate of capacity utilization
				Percent
Ethylene	1,162	1,029	1,830	64
Propylene	750	910	1,076	70
Butadiene	187	132	345	54
Total	2,099	2,071	3,251	65

About 30 percent of British chemical industry costs are attributable to labor. Between 1981 and 1983, the number of employees was reduced by 17 percent from 441,000 to 366,000. The combination of labor cost cuts and capacity closures was not sufficient to offset the large disadvantages which arose from raw material cost increases. Between 1975 and 1983, raw materials cost in the United Kingdom rose by 177 percent. 7/

1/ "Europe Not Lagging - Hoechst Chief," European Chemical News, Oct. 22, 1984, p. 15.
2/ Ibid.
3/ "R-P's Renaissance could be the Real Thing," Chemical Business, January 1985, pp. 21-28.
4/ "UK Chemical Competitiveness Said to Lag," Chemical Marketing Reporter, Mar. 12, 1984, p. 9.
5/ "Recovery for U.K. Chemicals Output Continues; Prices are Firmer," Hydrocarbon Processing, June 1984, p. 17.
6/ Chimie Actualities, Sept. 17, 1984, p. 5.
7/ "U.K. Competitiveness Said to Lag," Chemical Marketing Reporter, Mar. 12, 1984, p. 9.

British chemical firms have been attempting to make their commodity petrochemical operations more cost competitive by converting older facilities to accept natural gas feedstocks. One British producer will recommission a 250,000 metric ton-per-year ethylene facility at Grangemouth, Scotland after converting it to take North Sea natural gas liquids feedstocks. 1/ This converted plant is expected to have a 25 percent cost advantage when compared with other European plants using naphtha feedstocks. Another natural gas based unit is being constructed at Mossmoran, Scotland. This facility will have a capacity of around 500,000 metric tons per year of ethylene and is expected to be operational during the first half of 1986. 2/

The United Kingdom also has the largest methanol producer in Western Europe at Billingham, England. The facility is fed by North Sea natural gas and has a capacity for 700,000 metric tons per year. This same firm will be a joint-venture partner in a 500,000 metric ton-per-year methanol plant to be located in Trinidad which is expected to be onstream in 1988. 3/ The firm is also a joint-venture partner with a privately held Saudi Arabian company to produce polyurethane at Damman in Saudi Arabia. 4/

The British industry feels that it needs more time to rebuild the infrastructure which was lost during 1979-82. It also feels that by selective investments in natural gas based production units both domestically and abroad, the U.K.'s basic petrochemical industries can lead Western Europe in competing against producers located in CERN's. 5/

Other Western European countries.--Of the remaining countries in Western Europe which have traditionally been suppliers of basic commodity petrochemicals, only those with access to natural gas feedstock supplies are expected to remain reasonably economically competitive within the European trading community. However even these latter countries, such as the Netherlands and the Scandinavian countries, both with North Sea gas, cannot hope to compete with the Middle Eastern gas prices and, as of the present time, no major commodity petrochemical projects are planned for the near future. 6/

Western European firms, like their U.S. counterparts, view their future in terms of specialty chemicals. Certain European firms which were heavily involved in basic petrochemicals have already made the necessary adjustments

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1/ "International Forecast, A Business Pickup for Non-U.S. Companies," Chemical Week, Jan. 25, 1984, p. 66.
2/ Ibid.
3/ Chemical & Engineering News, Aug. 13, 1984, p. 7.
4/ "ICI Forms Polyurethanes Joint Venture in Saudi Arabia," European Chemical News, Jan. 2/9, 1984, p. 26.
5/ "UK Chemical Competitiveness Said to Lag," Chemical Marketing Reporter, Mar. 12, 1984, p. 9.
6/ "Recovery Is Underway But Overcapacity Remains a Problem," Chemical & Engineering News, Dec. 19, 1984.

to exit the commodities trade and focus on marketing specialty chemicals. 1/ If further rationalization in the commodity petrochemicals sector can be made, Western European chemical producers feel that there will again be stabilization in their domestic markets. 2/

Japan

Basis for development

Production of basic commodity petrochemicals by Japanese domestic industries is based on naphtha feedstocks. 3/ As a result, the industry found it was susceptible to the same economic pressures exerted on the other traditional commodity petrochemical producers by the newly developed, energy-rich nations whose production was based on natural gas. The Japanese industry recognized that it had lost 0.8 percent of its share of the world petrochemical trade in the 10-year period, 1970 to 1980. 4/

Japan's petrochemical industries are completely dependent on imported feedstocks. The following tabulation shows the extent to which Japan is capable of sustaining petroleum supply and satisfying their domestic demand in the event of another petroleum-supply disruption (in millions of barrels per day): 5/

Item	Japan	United States
Demand	4.0	15.5
Domestic production	0	10.3
Imports	4.5	5.1
Percent of total damand from Persian Gulf	65	5
Days supply of imports held as inventory	1/ 97	2/ 294

1/ Includes Japanese Government-owned stocks.
2/ Includes Stategic Petroleum Reserve.

Current competitive status

Petrochemicals play an important role in the Japanese economy. The industry accounts for about 3.8 percent of the nation's GNP. Total yearly shipments amount to roughly $38 billion. The industry produces all chemicals,

1/ "Business Picking Up for Revamped Union Carbide Europe," Chemical and Engineering News, Aug. 27, 1984, pp. 11-12.
2/ "Recovery Is Underway But Overcapacity Remains a Problem," Chemical & Engineering News, Dec. 19, 1984.
3/ "The Changing Pattern in World Trade," presentation by M. Pete Shimada at Europe and Chemical Marketing Research Association Meeting, Oct. 18, 1984.
4/ Ibid.
5/ "Five More Years of Lower Oil Prices, Barring Middle East Disaster," Hydrocarbon Processing, June 1984, p. 21, U.S. statistics are also shown as a reference case.

from basic commodities to specialty products used by high-tech industries. Total industry employment is approximately 140,000. 1/

As a result of the direct tie of Japanese commodity petrochemicals to imported crude petroleum and naphtha, both Saudi Arabian and Canadian products will be strongly competitive in the Japanese market. It has been estimated by one U.S.-based consultant firm that in 1985, Japanese domestically produced ethylene will be about 63 percent higher in cost than the Saudi product. 2/

Elimination of excess capacity for basic commodity petrochemicals was undertaken in Japan starting with the 1979 "Temporary Measures Law for the Structural Adjustment of Specific Industries," a measure put forward by the Japanese Ministry of International Trade and Industry (MITI). By mutual agreement, the petrochemicals producers would scrap excess capacity in such a way that unemployment would be minimally increased. Then, through the mechanism of joint sales companies, the products would be marketed in such a manner that price wars would be prevented. The concept, according to sources within the Japanese industry, is consistent with the social custom of "sharing poverty" 3/ as practiced in Japan for centuries. The tabulation that follows shows the commodity petrochemicals and the amounts of capacity which the joint Industrial Structure Council decided must be eliminated to achieve a viable level of competitive production by 1985 (in thousands of metric tons): 4/

Commodity	Necessary capacity for 1985	Capacity in August 1982	Excess capacity to be closed
			Percent
Ethylene	4,054	6,347	36
LDPE	1,064	1,667	36
HDPE	739	1,007	27
Polypropylene	1,205	1,252	-
Polystyrene	743	869	-
Styrene	1,331	1,761	24
Etyhlene oxide and ethylene glycol	542	743	27
PVC	1,517	2,007	24

1/ "The Changing Pattern in World Trade," presentation by M. Pete Shimada at Europe and Chemical Marketing Research Association Meeting, Oct. 18, 1984.

2/ "DeWitt Panel, Costs of Feedstocks to Dip," CPI Purchasing, May 1984, p. 90

3/ "Reconstructing the Japanese Petrochemical Industry," by Mutsumi Hongoh, Senior Managing Director, Idemitsu Petrochemical Co., Ltd., ECMRA/CMRA Conference, Venice, Italy, Oct. 17-18, 1983.

4/ The Industrial Structure Council.

Of the total 1982 commodity petrochemical capacity, 27.4 percent is to be eliminated by 1985, with the greatest cuts to be in ethylene and low-density-polyethylene (LDPE) production facilities. Apparent consumption of ethylene derivatives has been increasing in Japan since 1979 as shown in the following tabulation (in thousands of metric tons): 1/

Year	Production	Exports	Imports	Apparent consumption	Ratio of imports to consumption
					Percent
1979	4,700	2,900	1,000	2,800	36
1980	4,100	2,300	900	2,700	33
1981	3,700	2,100	1,200	2,800	43
1982	3,600	2,000	1,900	3,500	54

Projected demand for ethylene in 1990 is around 4.4 million metric tons. 2/ Only 87 percent of this estimated demand is expected to be met by domestic Japanese producers. For the remainder, Japanese firms have invested in several world-scale projects in both the Middle East and Far East. In Saudi Arabia, a consortium of Japanese firms are joint-venture partners in the SHARQ complex producing ethylene glycol (300,000 metric tons per year) and LDPE (130,000 metric tons per year). Another Japanese consortium is the joint-venture partner in the Saudi Methanol Company with a 600,000 metric ton-per-year capacity. 3/ In both cases, the Japanese partners, in addition to taking a major share of the output, act through associated Japanese trading companies to market the products in the Far East. 4/

The chemical complex at Pulau Ayer Merbau in the Republic of Singapore operated by the Petrochemical Corporation of Singapore (PCS) also is backed by a group of Japanese firms. 5/ This consortium holds 50 percent of PCS' capital. But since the complex is based on naphtha feedstocks, the Japanese

1/ Compiled from data in "The Changing Pattern in World Trade," by M. "Pete" Shimada of the Petrochemicals Division, Mitsui & Co., Europe, ECMRA/CMRA Conference, Venice, Italy, Oct. 17-18, 1983.

2/ Ibid.

3/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983.

4/ Compiled from data in, "The Changing Pattern in World Trade," by M. "Pete" Shimada of the Petrochemicals Division, Mitsui & Co., Europe, ECMRA/CMRA Conference, Venice, Italy, Oct. 17-18, 1983.

5/ "Singapore's Chemical Complex On-Stream One Year Late," European Chemical News, Feb. 20, 1984, p. 9.

interests have been reluctant to commit themselves to a firm percentage of imports from the operation. 1/

A more economically promising venture for Japanese investors could be in Malaysia. Malaysia is seeking a Japanese partner to invest in a 200,000 metric ton-per-year ethylene plant that could be built and onstream by 1990. 2/ This plant would use low-priced natural gas as a feedstock and hence be more competitive than the Singapore complex.

By overall industry cooperation, Japan is successfully reducing its excess capacity for certain commodity petrochemicals. Also, through the marketing tactics of its trading companies, the nation has been able to secure new markets and firm relationships with old trading partners. 3/

The Japanese trading company is a unique facility for establishing Japanese-foreign industrial trade relationships. They are staffed by graduates of a special Japanese trading university which schools students in marketing, languages, and customs. 4/ These graduates are then rotated worldwide acting as international trading specialists. The structure of these trading companies has allowed Japanese manufacturers to circumvent dealing directly with their customers, and therefore, they do not have to maintain an extensive marketing staff. The trading companies also provide a mechanism for international marketing of products made by small capacity Japanese firms, hence, opening world markets to these smaller industries which could not afford independent foreign offices. 5/

At present, the chemical sector of the Japanese economy is reported to be doing extremely well. Production in the petrochemicals sector in the first half of 1984 averaged 22 percent ahead of output in 1982. The restructuring of the ethylene industry has been very successful, and the 1984 economic improvement has made it necessary to increase imports of ethylene on an emergency basis. 6/ The industry still intends to complete its planned capacity reductions for 1985. 7/

The Japanese Government has remained cognizant of the fact that Japan possesses no petroleum resource base. The restructuring of its petrochemical industry appears to leave a margin for growth which is consistent with projected increases in demand and shows that Japan has no interest in attempting to compete with the lower cost products coming out of energy-rich

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1/ Ibid.

2/ "Petronas Invites Japan to Invest in Malaysia," European Chemical News, March 26, 1984, p. 22.

3/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983.

4/ Ibid.

5/ "Japan is Displacing the United States As Saudi Arabia's Leading Supplier; Many Possible Reasons Are Cited," Business America, June 25, 1984, pp. 14-15.

6/ "Lusty Economy Revives Japanese Chemicals," Chemical & Engineering News, Aug. 6, 1984, p. 9.

7/ Ibid.

nations. 1/ The Japanese Government feels that its goals must be to provide stability to the industry to meet domestic demands and to develop its more sophisticated downstream specialties areas for applications in its high-tech industries. 2/

Conventional Energy-Rich Nations

Canada

Natural resources located in Canada, the largest country in the Western Hemisphere and the second largest country in the world, are administered by each province. However, in the two territories because of their remoteness and sparse population, the resources are federally administered. 3/

Basis for development

The following tabulation shows 1980 and projected 1990 Canadian annual capacities for certain commodity petrochemicals, as expected in 1983 (in thousands of metric tons). 4/

Product	1980	1990	Percentage increase between 1980-90
Ethylene	1,600	3,700	131
Ammonia	2,065	4,105	99
Methanol	450	2,000	344

The projected figures for 1990 in the previous tabulation have since been revised slightly downward as the 1982 recession in Canada slowed industry initiatives in the Western Provinces and the Canadian National Energy Plan (NEP) created a situation in which plants based on natural gas feedstocks grew less competitive. However, Canada has a sound natural resource base to support projects of this magnitude. The one factor which has prevented the Canadians from becoming a more powerful force in the world market has been the Canadian Government's energy policy. 5/ Presently, a high up-front tax is imposed on petroleum and natural gas feedstocks. This tax has caused the price of Canadian commodities to be equivalent to U.S. gulf coast material. The disadvantage suffered by the Canadian industries was illustrated to the government by a task force study conducted by Canadian petrochemical

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1/ Compiled from data in "The Changing Pattern in World Trade," by M. Pete Shimada of the Petrochemicals Division, Mitsui & Co., Europe, ECMRA/CMRA Conference, Venice, Italy, Oct. 17-18, 1983.

2/ "Lusty Economy Revives Japanese Chemicals," Chemical & Engineering News, Aug. 6, 1984, p. 9.

3/ The Statesman's Yearbook, 118th Ed., 1981-82, and Statistics Canada, Canada Yearbook 1980-81.

4/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983.

5/ "Rx for Canadian Feedstocks," Chemical Week, Feb. 15, 1984.

producers. 1/ The task force recommended to both federal and provincial governments that a 15 percent reduction be made in the price of natural gas and that the oil-based segment of the industry switch to propane and butane as feedstock. 2/ Countering the petrochemical industry's recommendations, however, was a statement issued by a representative of the Canadian petroleum industry, also representing the producers of natural gas. They felt that the price was already below replacement costs and that more benefit would be realized by both chemical producers and natural gas suppliers if the governments would significantly reduce the taxes charged to industrial gas and crude oil consumers. In either case, the NEP is pinpointed as the reason that Canadian oil and gas prices are above world prices, thus hurting the Canadian industries in the world market. 3/

Current competitive status

In September 1984, the 193,000-metric-ton-per-year ethylene plant at Varennes, Quebec, started mothballing its operation. 4/ However, since that time, the Canadian Government has granted a $15 million reprieve in order to keep the ethylene plant onstream, matching a $15 million grant from the Provincial Government. 5/ The plant is owned by a Canadian petrochemical company which is considered the cornerstone of petrochemical production in the Montreal area. This firm is a joint venture of a subsidiary of a U.S.-based multinational and the Quebec Government. Company executives place the blame for its fiscal failures on the Provincial and Federal taxes levied on feedstocks, arguing that 75 percent of feedstock costs are attributable to these charges. The Varennes facility was operated with naphtha as the principal feedstock. 6/ Its nameplate ethylene capacity of 193,000 metric tons per year represents 78 percent of the total ethylene capacity of the Montreal area. The remaining plant, Montreal East, has a nameplate capacity of 54,000 metric tons per year. During the past few years, the Varennes plant was operating at only 60 percent of capacity. When a major U.S.-based multinational announced the closing of its polyethylene unit at Montreal East, the Varennes ethylene plant lost its major customer. The combination of world overcapacity for ethylene and high feedstock costs forced the Canadian firm to announce its plans for the mothballing of the unit. 7/

1/ Ibid.

2/ Petrochemical Industry Task Force Report, February 1984.

3/ Corpus Chemical Report, Feb. 13, 1984, pp. 1-52.

4/ "Troubles Plague Montreal Petrochemicals Industry," Chemical & Engineering News, Sept. 3, 1984, pp. 15-16.

5/ "Petromont Gets Canadian Government Help," Chemical & Engineering News, Oct. 15, 1984, p. 11.

6/ Ibid.

7/ Ibid.

The Varennes situation is a good example of the problems associated with the NEP. The Canadian commodity petrochemical producers feel that it is remarkable that a nation with such a favorable natural resource base should become borderline competitive in the world petrochemical marketplace. 1/ They also believe, however, that the provisions of the NEP have seemingly produced this result. 2/ Although at the time of its enactment the NEP promised to give Canada a competitive edge in energy and petrochemicals, the unanticipated effects of worldwide recession and effective energy conservation measures caused world energy prices to decline while the prices of Canadian feedstocks remained high. Provisions of the NEP were written at a time when long-run projections predicted rapid and continuous increases in crude petroleum and natural gas price. It was also assumed that reserves of these resources would diminish and no new deposits of any significant quantity would be found. 3/

Canadian commodity petrochemical production for some selected products is shown in the following tabulation (in thousands of metric tons). 4/

Product	1981	1982	1983
Ethylene	1,330	1,013	1,196
Propylene	671	693	715
Benzene	572	519	580
Methanol	NA	NA	1,670
Ammonia, anhydrous	2,654	2,508	2,888
Urea	NA	1,231	1,445

Most Canadian firms rebounded in 1983 from the downturn in production recorded in 1982. The increase in production was attributed to increased demand from Canada's trading partners, primarily the United States. 5/

Capacity utilization for the Canadian industries was improved in 1983. Petrochemical plants in eastern Canada which employ refined petroleum as feedstocks operated at lower rates than those using natural gas in the western part of the country. 6/

Regardless of the economic setbacks suffered by the Canadian petrochemical industries in 1982, most planned projects have continued to be developed. By 1990, Canada still wants to double its share of the world market for certain commodity petrochemicals. If the industry can convince the Provincial and Federal Governments that a new energy policy is essential to bolster their world trade position, the Canadian petrochemical industry, based on Canadian natural gas resources, is expected to become formidable competitors in international trade. 7/

1/ "Adaptability Urged For Canada's Economy," Chemical & Engineering News, Jan. 16, 1984, pp. 28-30.
2/ Petrochemical Industry Task force Report, February 1984.
3/ Ibid.
4/ Compiled from official statistics of Statistics Canada.
5/ Ibid.
6/ "Adaptability Urged For Canada's Economy," Chemical & Engineering News, Jan. 16, 1984, pp. 28-30.
7/ Petrochemical Industry Task Force Report, February 1984.

Saudi Arabia

Basis for development

Saudi Arabian resources include 24 percent of the world's proven crude petroleum reserves and approximately 117 trillion cubic feet of natural gas. These hugh low-cost resources give the new commodity petrochemical industry in Saudi Arabia a considerable competitive price advantage over most world-scale producers, particularly those in Western Europe. The estimated costs to Saudi producers of commodity petrochemicals for natural gas feedstocks are approximately 50 cents per thousand cubic feet. 1/

The Government of Saudi Arabia, which is fostering the development of the large-scale petrochemical industry, is doing so in part to make Saudi Arabia less dependent on foreign sources for downstream petrochemicals and finished products, and to capitalize on the kingdom's vast petroleum and natural gas reservoirs by producing second and third generation petrochemical derivatives. 2/

Current competitive status

The following tabulation shows a summary of the petrochemical capacity which has already come onstream, and is expected to come onstream in Saudi Arabia during 1983-90 (in thousands of metric tons per year): 3/

Product	Capacity
Ammonia	300
Ethylene	2,800
Ethylene dichloride	465
Ethylene glycol	520
HDPE	160
Industrial ethanol	281
LDPE and LDDPE	670
MTBE	500
Methanol	1,250
PVC	222
Styrene	295
Urea	500
VCM	300

1/ Chemical Business, September 1984, pp. 10-16.
2/ Ibid.
3/ Data compiled from various sources by the staff of the U.S. International Trade Commission including: "SABIC Gears for Full Operation of $12 Billion Chemicals Complex at Al-Jubail and Yanbu Locations," Chemical Marketing Reporter, Jan. 21, 1985, pp.5, 34; and "Supplier Profile," CPI Purchasing, December 1984, p. 15.

These world-scale petrochemical projects are either joint ventures between SABIC, the state-owned corporation for the establishment of capital-intensive industry projects, and several of the world's largest petroleum and chemical companies, or private Saudi investments. Feedstocks for these plants will be derived from natural gas which was previously burned ("flared") during the processing of crude oil. Collecting and using this formerly wasted gas gives the kingdom an extremely cheap source of raw material. 1/ In exchange for the cost advantage of the natural gas feedstocks, the joint venture partners have agreed to market that portion of the production earmarked for export, and to train Saudi workers in the operation of the facilities. Saudi Arabia then benefits from having established worldwide foreign marketing and distribution networks for its goods and having its citizens trained in skilled technical areas. The Saudis project their 1990 capacity in basic commodity petrochemicals to be about 6 percent of the total world capacity. 2/

The presence of the Saudi facilities has been already felt in Europe. The plant at Al-Jubail, National Methanol Company (Ibn Sina), jointly operated by Sabic and two U.S.-based multinationals, began shipments of methanol to Far Eastern markets and the EEC in July 1984. The first shipments included a 26.5 million pound parcel to India and 5.5 million pounds to Spain, both priced at $140 per metric ton. A second deal has also been concluded by Sabic for delivery of 44 million pounds (20,000 metric tons) to India at $155 per ton. 3/ The methanol from the Al-Jubail plant was shipped by chemical tankers owner by a Norwegian firm with a long-term contract with the National Methanol Company. 4/ In 1985, a 43,000-dwt methanol carrier is scheduled to be delivered to the National Shipping Company of Saudi Arabia. The ship, built in South Korea, will be chartered by the National Methanol Company and used exclusively for shipments of this chemical. 5/

Shipments of methanol from the first Saudi methanol unit onstream owned by the Saudi Methanol Company, which began production in April 1983, have totaled 107,000 metric tons to the EEC and 100,000 metric tons to other markets. 6/ SABIC also plans to establish a U.S. sales office in either New York or Houston to market approximately 120,000 metric tons of methanol and 100,000-150,000 metric tons of ethylene glycol in the United States. 7/

1/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983.
2/ Ibid.
3/ "Saudi Methanol Sales Start to Increase Pace," European Chemical News, Sept. 3, 1984, p. 6.
4/ "Enichem Signs Commercial Pact With Saudi Chemical Industry," European Chemical News, July 9, 1984, p. 10.
5/ "Distribution Patterns for Methanol to Change," European Chemical News, Jan. 2 and 9, 1984, p. 14.
6/ "Saudi Methanol Sales Start to Increase Pace," European Chemical News, Sept. 3, 1984, p. 6.
7/ "Who's Who in Saudi Chemicals," Chemical Week, Jan. 16, 1985, p. 10.

By mid-1985, Saudi ethylene capacity will be 1.6 million metric tons per year. 1/ This will represent approximately 3 percent of the world's total capacity. Although the Saudis will not have a major share of world capacity, their feedstock price advantage could enable them to direct the market price for the commodity. It is estimated that the Saudi-produced ethylene could be priced at $258 per ton, 48 percent less than U.S. material, 61 percent less than European and 63 percent less than the Japanese product. 2/

Other Conventional Energy Rich Nations

Mexico

Petroleos Mexicanos (PEMEX), a government owned corporation formed in 1938, is the sole owner of "basic" commodity petrochemical industries in Mexico. The ownership extends to some first and second generation derivatives as well. Mexico's industrial power in petrochemicals resides primarily in its extensive natural resource base. As of January 1, 1985, Mexico's proven crude petroleum reserves were 48.6 billion barrels, placing it fourth in the world behind Saudi Arabia, Kuwait, and the Soviet Union. 3/

Utilizing its position as the world's fourth largest source of crude petroleum, Mexico feels it can both provide for its own growing demand for petrochemicals and also become one of the largest producers for the international market. Its proximity to the United States, the largest and most stable market for commodity petrochemicals, gives Mexico a marked advantage when compared with the Middle Eastern nations. But PEMEX, which does not permit any joint-venture operations where basic commoditity petrochemicals are concerned, also retains some first and second downstream derivatives for its quasi-Government ownership. 4/ This makes it necessary for Mexico to develop its own distribution and marketing structure, whereas Saudi producers, for example, can use their joint-venture partners' already established marketing networks. The Mexican Government recognizes the obvious drawbacks to this situation. In February 1984, Mexico's National Commission on Foreign Investment addressed the problem by announcing that the Government planned to promote foreign investment in certain key industrial areas. 5/ The announced reason was to bring in foreign investment capital and to develop downstream industries, a weak point in Mexico's industrial structure. 6/

In 1982, Mexico had a petrochemical trade deficit of $400 million. 7/ In 1982, imports of chemicals were valued at $2.2 billion, but exports were only

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1/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983.

2/ Ibid.

3/ "Worldwide Report," Oil & Gas Journal, Dec. 31, 1984, pp. 74-75.

4/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983, pp. 104-121.

5/ "Mexico: U.S. Exports Increase As Adjustment Continues," Business America, Aug. 20, 1984, p. 25.

6/ Ibid.

7/ "International Forecast," Chemical Week, Jan. 25, 1984, pp. 74-76.

$771 million. The majority of these imported chemicals are plastic resins, monomers, and specialty chemicals. Burdened with the foreign exchange problems generated by these imports, the Government imposed austere import limitations in 1983. As the domestic petrochemical industry lacked the structure to supply demand, there was no growth until early 1984 when modest upturns were reported. 1/ Mexico hopes to turn around this situation as more foreign investment is attracted by the prospects of low feedstock costs.

The immediate need for foreign exchange implies the need for Mexico to push for export expansion. In a world sensitive to feedstock costs, the natural advantage which Mexico's resources provide should give it the necessary competitive edge. However, industry analysts are forecasting significant declines in Mexican commodity petrochemical exports. 2/ This forecast decline is attributed to a combination of growing domestic demand and failures to meet plant construction schedules.

The nation plans to develop its own base in downstream products, pharmaceuticals, and specialties to alleviate the large volume of imports of these materials needed to meet domestic demand. PEMEX also plans to eventually become competitive in the world market for these products. 3/

Middle East nations

The seven countries of the Middle East, other than Saudi Arabia, which now have or could potentially develop large petrochemical complexes are Kuwait, Iraq, Iran, Bahrain, Oman, Qatar, and the United Arab Emirates (UAE). Kuwait, Bahrain, Oman, Qatar, the UAE, and Saudi Arabia are part of a working group called the Gulf Cooperation Council (GCC). 4/ The GCC has its headquarters in Qatar and acts as coordinator of industries for its members. It tries to prevent overlapping of projects so that the member countries can achieve sufficient market autonomy within particular industrial sectors and, thus, operate plants at maximum efficiency. Besides Saudi Arabia, Kuwait is the member of the GCC which has the most progressive plans for its petrochemical industry. 5/

The nations comprising the GCC, (excluding Saudi Arabia, which has been considered separately in this report) along with Iraq and Iran, have begun development of a petrochemical industry which they can support with their extensive natural resource base. 6/ As in the case of Saudi Arabia, these undertakings have been accomplished along with joint-venture partners which are mainly multinational chemical corporations. Because of political and religious sect hostilities, two of these nations, Iraq and Iran have not been

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1/ "Inflation Slows Mexican Recovery," Washington Post, July 15, 1984, p. A1, A22.
2/ Chemical Week, Aug. 22, 1984, p. 15.
3/ Ibid.
4/ "Middle East: The Small Picture," Chemical Business, June 1984, p. 57.
5/ Ibid.
6/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983.

able to pursue a path of consistent development within their value-added petrochemical strategies.

The Iraq-Iran War started in 1980 and has resulted in significant and repeated damage to crude petroleum refineries, petrochemical plants, and water and land transportation facilities in both nations. Iran suffered the greatest loss of potential downstream petrochemical income when, in the first year of the war, the industrial complex at Bandar Khomeini in southern Iran came under repeated aerial attack from Iraqi warplanes. 1/ The complex was about 85 percent complete at the time of the initial attacks and, although attempts have been made to restore the plants, Iraqi attacks continue. The most optimistic industry analysts predict the project to be completed around 1988. 2/ The complex is a joint-venture of the Iranian Government and a Japanese consortium. The facilities will produce ethylene and a number of derivative products. Construction costs are now estimated to be around $4 billion. 3/

Both belligerents have sustained economic as well as physical damage. Iraq's oil outlet on the Gulf has been closed since 1980 and the pipeline across Syria has been closed since 1982. 4/ The diminution of Iraqi crude petroleum trade has made it necessary for the Government to acquire financing for most of its projects and transactions. With the war expenses draining the financial resources of the nation, capital is simply not available for other purposes. 5/

The Gulf war's economic disruption has also spilled over into bordering nations. Kuwait's transshipment trade, estimated at around $1 billion per year, has been seriously curtailed, since Iraq was the principal consumer. The reduction in world crude petroleum trade has caused Kuwait to rethink its petrochemical plans and instead concentrate on foreign investments. It has added retail outlets for its petroleum products in Italy this year. In 1983, the country purchased retail facilities and refineries in Scandinavia and the Benelux countries from a multinational petroleum company. These purchases have given the Kuwaiti petroleum industry a guaranteed market for a portion of its production and provides a buffer from fluctuating world markets. 6/

Kuwait was the first Persian Gulf nation to utilize its previously flared natural gas as a feedstock in the production of ammonia and urea; Kuwait has become one of the world's largest fertilizer producers. The following tabulation shows production capacity for ethylene, ammonia, and methanol in 1980 and a projection for 1990 (in thousands of metric tons). 7/

1/ "Iran Chemical Project is Slated to Continue Despite War With Iraq," Chemical Marketing Reporter, July 16, 1984, p. 4.
2/ Ibid.
3/ Ibid.
4/ "Iraq: Promise of Pipelines Could Improve Limited Finances," Business America, Aug. 20, 1984, p. 54.
5/ Ibid.
6/ Ibid.
7/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983, p. 87.

Product	1980	1990
Ethylene	45	395
Ammonia	636	1,296
Methanol	45	250

Kuwait is looking for a joint-venture partner to build a 32,000 metric ton-per-year polystyrene plant and a 20,000-ton-per-year phthalic anhydride plant, both of which would be operating by 1987. 1/ A letter of intent has been signed with a West German chemical firm covering the marketing of ammonia and chemical fertilizers. 2/ Kuwait holds a 25 percent interest in this West German concern and has a representative on its board of directors.

Other projects under consideration within the GCC are shown in the following tabulation (in thousands of metric tons per year). 3/

Product	Capacity	Partners
Ammonia	450	Sharjah - French Company
Methanol	600	Sharjah - French Company
Urea	600	Sharjah - French Company

No startup date has been proposed on any of these projects as of this time.

The Middle Eastern nations see their economic future linked to downstream petrochemicals produced from their abundant natural gas. The world-scale chemical complexes can supply their own demand and provide an additional source of revenue linked to their natural resources. In addition, the joint-venture partners are expected to provide training for host nation citizens as plant operators. 4/

Nigeria

The military government of Nigeria has given its approval to initiate the development of a $2 billion petrochemical industrial complex which will utilize the country's abundant natural gas reservoirs as feedstock. 5/ Port Harcourt will be the site of the facilities. A satellite town for 30,000 people is also a part of the plan. The nation's major crude petroleum

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1/ "KPPC Will Shortly Issue Bids for PS, Phthalic Anhydride Plants," European Chemical News, Mar. 19, 1984, p. 18.

2/ "Hoechst Signs Kuwaiti Co-operation Deals," European Chemical News, Feb. 6, 1984, p. 4.

3/ "Mideast Chemicals Buildup Continues," Chemical Week, Feb. 1, 1984., p. 20, and "ICI Plans to Build World-Scale Methanol Plant in Sharjah," European Chemical News, Jan. 2/9, 1984, p. 23.

4/ Ibid.

5/ "Nigeria Gives Go-ahead for $2bn Petrochemical Complex," European Chemical News, July 9, 1984, p. 28.

refinery is located at Port Harcourt and is expected to provide the feedstocks for the planned complex. 1/

The following tabulation is a partial list of the products and capacities of the proposed facility (in thousands of metric tons): 2/

Product	Capacity
Butene-1	15
Ethylene	400
Ethylene glycol	35
2-Ethylhexanol	26
Polyethylene	270
Propylene	100
Polypropylene	70
Phthalic anhydride	15
Plasticizers	30
Vinyl chloride monomer	145
Polyvinyl chloride	140

The site is expected to be completed by 1990 and will employ approximately 10,000 people during the construction phase, and around 3,000 permanently for operation and maintenance. Nigeria has already progressed into its petrochemical development plans with the construction of a linear alkyl benzene unit using products from the refinery at Kaduna, and has further plans for carbon black and propylene units to be built near the Warri refinery. 3/

On October 19, 1984, Nigeria announced that it would lower its export price on a barrel of crude oil by $2, matching a similar reduction by Norway and the U.K. 4/ The Nigerian price of $28 per barrel was set to maintain production levels so that the country could meet its growing international debt. Nigeria has historically made such price reductions, as in March 1983 when it met the first reduction by the U.K. 5/

Far East nations

In addition to those in Japan, commodity petrochemical production facilities are operating in Taiwan, Singapore, Malaysia, and the Republic of Korea (Korea). In at least two of these countries, Singapore and Malasia, Japanese firms have provided substantial amounts of investment capital to construct the world-scale petrochemical facilities. 6/

1/ Ibid.

2/ Ibid.

3/ Ibid.

4/ "Nigeria Lowers Oil Price by $2," The Washington Post, Oct. 19, 1984.

5/ Ibid.

6/ "Singapore's Chemical Complex On-Stream One Year Late," European Chemical News, Feb. 20, 1984, p. 9; and "Taiwan Ethylene On-Stream," European Chemical News, Aug. 20/27, 1984, p. 10.

With the exception of Malaysia, the plants in these Eastern countries are predominantly run using naphtha feedstocks. Malaysia has deposits of natural gas and can support some petrochemical industry based on NGL feeds.

The following tabulation shows some of the petrochemical manufacturing plants and locations in the Far East (in thousands of metric tons): 1/

Location	Product	Annual capacity	Operational status
Korea	LLDPE	80	Planned
	Styrene	80	Planned
	Terephthalic acid	160	1985
Malaysia	Ethylene	200	Planned
	Methanol	660	Operating
Singapore	Ethylene	300	Operating
	Propylene	160	Operating
	Butadiene	45	Operating
	Aromatics	130	Operating
	Polypropylene	100	Operating
	Ethylene glycol	87	Operating
	LDPE	120	Operating
	HDPE	80	Operating
	Ethylene oxide	80	1985
Taiwan	Ethylene	920	Operating
	Propylene	175	Operating
	Butadiene	53	Operating

Since the Far Eastern nations have, for many years, been the producers of finished consumer goods, especially textiles made from synthetic fibers and miscellaneous plastics products, 2/ integration back to the basic commodity petrochemicals could offer these countries the added economic advantage of domestically controlled sources of plastic resins. As the industries are dependent on imported petroleum or refined petroleum feedstocks, they are not on the same competitive level with the CERN producers, and the major reason for their development is to satisfy downstream domestic demand. 3/

Although the Pacific Basin nations have petrochemical industries which are tied closely to their export end-product market lines, they feel that their own growing demand can sustain these world-scale operations, even if their Western customers should experience another economic recession, thereby creating another worldwide economic slowdown. 4/

1/ Ibid., and "ECN Project Summary," European Chemical News, various issues.
2/ "The Republic of China - A New Economic Era," Time, Sept. 3, 1984.
3/ "Jumping For Joy in the Pacific," Time, Nov. 12, 1984, pp. 78-80.
4/ Ibid.

Nonmarket Economies

The two largest of the nonmarket economies, the Soviet Union and the People's Republic of China (China), are not only self sufficient in energy sources, but have the potential to develop sizeable petrochemical industries. The need for capital in most of the nonmarket economies to purchase agricultural products from Western nations provides a motive for the Council for Mutual Economic Assistance (Comecon) 1/ countries to concentrate on building a basic commodity petrochemical sector devoted to export sales. 2/

Traditional petrochemical trade for the nonmarket countries has been restricted to internal exchanges of raw materials and finished products. Chemical imports were limited to certain materials for which little or no production capacity existed and no substitution could be made. Specific data on production and Comecon trade is not readily available; however, an overview of areas of petrochemical production is as follows: 3/

Country	Description of specialty
Bulgaria	Certain fibers, pharmaceuticals, cosmetics, synthetic rubbers, pesticides, dyes and intermediate chemicals.
Czechoslovakia	Textiles, rubber additives, dyes, reagents, and polypropylene fibers.
East Germany	Dyes, photochemicals, fertilizers, and plant protection agents.
Hungary	Certain pharmaceuticals.
Poland	Phthalic anhydride, maleic anhydride, synthetic rubber, fertilizer, certain plastics, synthetic fibers, detergents, and certain pharmaceuticals.
Romania	Primary petrochemicals and polyisoprene rubber.

Future plans for development of petrochemical production in the Soviet Union and Soviet-bloc countries are closely allied with the availability of petroleum and natural gas feedstocks which can be delivered from the eastern

1/ Council for Mutual Economic Assistance. Established in the period 1949-51, the Council's mission is to coordinate development of its member countries. The council has headquarters in Moscow. Member countries account for 20 percent of the world's land mass and have a combined population of 433 million. Natash Alperowicz and Tony Cox, A Time of Transition: The East European Chemical Industry, 1981-85, London, December 1981, p. 9.

2/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983, pp. 123-138

3/ "Slow Growth Continues in Soviet Union and East Europe," Chemical & Engineering News, Dec. 19, 1983, pp. 46 and 47.

Soviet Union via a recently installed system of pipelines. The council has recommitted itself to improving the quality of industrial production within its membership. 1/

Soviet Union

The Soviet Union has large deposits of minerals, crude petroleum, natural gas and coal. The Soviet Union's proven crude petroleum reserves are estimated to be approximately 63 trillion barrels; Soviet Union natural gas reserves, which represent more than one-third of the world's proven reserves, total approximately 1.45 quadrillion cubic feet. 2/ At current production rates, these reserves could provide the Soviets with a 70-year supply of natural gas.

It has been the policy of the Soviet Union to preferentially provide its allies with low-cost crude petroleum. However, with production costs rising and an increasing need for hard currency, more crude petroleum is being allocated for sale to Western markets. 3/ Soviet-produced natural gas is also being diverted to the Western nations in order to increase currency reserves. The Siberian pipeline, which began operation on January 1, 1984, is expected to bring an estimated 35 billion cubic feet of natural gas into Western Europe in 1984. 4/

The Soviet Union's chemical industry is estimated to be the fourth largest in the world. 5/ Production problems associated with outdated facilities have been mainly responsible for the industry's historical performance. 6/ A second cause has been the lack of cooperation between various Government ministries that must work together to construct plants and assure their continued operation. One such example is the proposed ethylene and formalin plants at the Tomsk petrochemical complex. 7/

1/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy Rich Nations, USITC Publication 1370, April 1983, pp. 123-138

2/ "CMEA Summit Offers Few Solutions to Region's Problems," Business America, Aug. 20, 1984, pp. 18-20.

3/ "Worldwide Report," Oil & Gas Journal, Dec. 31, 1984, pp. 73-74.

4/ New York Times, Sept. 17, 1984, p. 6.

5/ "Soviet Gas Pipeline to Europe Starts Up," Chemical and Engineering News, Jan. 30, 1984, p. 18.

6/ "Ethylene and Formalin Plants at the Tomsk Petrochemical Complex Have Been Hit by Serious Delays," European Chemical News, Sept. 26, 1983, p. 21.

6/ Newspaper Enterprise Association, Inc., The World Almanac and Book of Facts: 1982, 1981, p. 587.

7/ "Soviets Could Drown World in Petroleum With Properly Upgraded Technology," Hydrocarbon Processing, January 1984, p. 23.

The Soviet Union, even with the problems associated with outdated technology, did show a 6 percent increase in chemical and petrochemical production in 1983 compared with production in 1982. 1/ The following tabulation shows the production volume of certain petrochemical products in 1983 and the increase compared with production in 1982 (in thousands of metric tons): 2/

	1983	Production increase 1982 to 1983 Percent
Fertilizers	29,700	11
Pesticides	600	4
Plastics	4,400	9
Synthetic fibers	1,400	10
Detergents	1,100	3

The Soviets are aware of the problems facing their petrochemical industry and have set goals to upgrade and expand their production to satisfy Comecon demand and increase exports to Western countries, especially in the area of basic commodity petrochemicals. Modernization of some synthetic fibers plants has also been planned in cooperation with a major British fibers producer. 3/ The Soviet Union also is continuing to plan and build new facilities for petrochemicals commodities. 4/

People's Republic of China

Although deposits of crude petroleum and natural gas are known to exist in People's Republic of China (China), very little is known about the extent of these deposits. Recently, two Western energy companies have located crude petroleum in the South China Sea, and another Western company has discovered an offshore field of natural gas. 5/

In keeping with China's demand for agricultural products, China's fertilizer production was 13.8 million metric tons in 1983, and 1984 production will be even greater. 6/ China is the third largest producer of fertilizers behind the United States and the Soviet Union. During the past 34 years, China's chemical fertilizer production has grown by 28 percent per year, and China now has more than 1,300 chemical fertilizer plants. New petrochemical complexes, such as the expansion proposed in Shanghai and

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1/ "Chemical and Petrochemial Output Rose 6% in 1983 vs 1982," European Chemical News, Feb. 13, 1984, p. 10.

2/ Europa Chemie, Feb. 23, 1984, p. 85.

3/ "USSR Chemical Plants Modernized by Courtaulds," Chemical Marketing Reporter, Aug. 13, 1984, p. 11.

4/ "Soviet Union Revives Major Acrylates Project in Dzerzhinsk," European Chemical News, Mar. 26, 1984, p. 22, and "Tecnimont Wins Order to Build Soviet Polycarbonates Plant," European Chemical News, Mar. 5, 1984, p. 18.

5/ "Arco Chinese Plan," European Chemical News, Sept. 24, 1984, p. 26.

6/ Beijing Review.

Zhenhai, include plants to produce 300,000 metric tons per year of ammonia and 540,000 metric tons per year of urea. 1/

Fertilizer demand is only one area where basic petrochemicals have potential growth in China. Industrialization on a Western scale is just beginning, and the basic substitution of products made using commodity petrochemicals replacing items made by traditional "cottage industries" has also begun. 2/ The new petrochemicals complex expansions at Shanghai will house a 300,000 metric ton per year polyester plant, while 3 plants located at Jianjsu, Shangdong, and Daqing will produce 300,000 metric tons per year of ethylene. 3/ China's present capacities for some basic commodity petrochemicals are as follows (in thousands of metric tons per year): 4/

Product	Capacity
Ethylene	600
Other plastics resins	500
Polyolefins	400
Synthetic rubber	140

Proposed expansions of commodity petrochemical and petrochemical product capacity which are receiving high priority are shown in the following tabulation (in thousands of metric tons per year): 5/

Product	Location	Capacity
Polyethylene	Liaowang	70
Polypropylene	Liaowang	70
Polyester	Liaowang	130
Byproducts	Liaowang	300
Certain Plastics	Nanjing	200
Synthetic Rubber Intermediates	Nanjing	40
Other Petrochemicals	Nanjing	900

Even with the massive expansions and additions planned, Chinese demand will still exceed supply; therefore, Chinese consumers are expected to depend on imports to supplement shortages and provide products not domestically produced. 6/ The overall planning and management is to be directed by China Petrochemical (Sinochem) acting on a ministerial level directly under the state council. The new agency must coordinate the development in line with the national goal of quadrupling gross domestic production by the end of this century. Certain moves have been made to accelerate the technology transfer

1/ "China: Has Ordered 42 Petrochemical Plants from the Western World as Part of a $3 Billion Expansion Programme Started in 1979," European Chemical News, Sept. 10, 1984, p. 4.

2/ Ibid.

3/ Ibid.

4/ Chemical Week, Jan. 25, 1984, p. 73.

5/ Ibid., pp. 72-73.

6/ "Chinese Leftists Take the 'Free' Out of Enterprise," The Wall Street Journal, Nov. 6, 1984.

from firms in the Western world, but vestiges of a more austere China still remain. 1/ In spite of some resistance, the Chinese Government seems committed to making the adjustments needed to modernize the Chinese industries. 2/

1/ Ibid.
2/ Ibid.

U.S. PETROCHEMICAL INDUSTRY STRATEGIES

The process of strategic planning within the U.S. chemical industry has become increasingly more important as production cost and feedstock availability advantages migrate from the United States and other traditional commodity petrochemical producers to conventional energy-rich developing regions of the world. The development of the strategic planning process itself occurred in the United States, and is most often attributed to Robert McNamara, then an executive with a major U.S. automobile manufacturer. 1/ His belief that short-term planning, as it was then practiced by the U.S. industry (through the 1940's) was beneficial to a limited extent, but that a group of planners solely dedicated to the mission of long-range forecasting should exist, adjacent to the line functions in the corporate structure, and act as advisors to the highest level of corporate management. Since the innovation of the strategic planning group, various methods designed to provide insight into the future have evolved, a few of which have proven to be better at forecasting than the others. However, the technical nature and bases for these methods precludes entering into any prolonged discussions concerning their derivations or the steps and processes used to accomplish their purposes. 2/

A typical strategic planning exercise needs to be undertaken in a logical, orderly fashion. Initially, strategic issues need to be properly identified. Misidentification inevitably leads to invalid reasoning and improper conclusions based on the misinformation. Methods of strategic issue identification include environmental scanning and monitoring of trends, and events or developments observed or reported in the media. 3/ These trends may be identified in the context of changes in the attitudes and behaviors of the general public; shifts in activities of groups such as stockholders, lenders, employees, or competitors; and changes in fiscal or monetary policy. Often, changes in Government policy on either the Federal, State, or local levels key the awareness of industry to certain strategic issues. 4/ Scientific and technical innovations are also especially important indicators for any segment of the chemical industry to monitor.

The strategic planning function within a large corporation, such as a producer of commodity petrochemicals, should be separated from the economic forecasting function within the same corporation. These functions, although often dependent on one another for information, need to be practiced independently, as the reliance of each function on different sets of assumptions and relationships between external factors can create inaccuracies. The planning function, which takes into consideration multiple responses in the event of changes in certain underlying factors, could lose a significant portion of its value if economic forecasts were accepted without greater examination of the contributing factors. 5/ The specific goals of the strategic planning function also need to be explicitly set so that an accurate

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1/ Peter Lorange and Richard Vancil, Strategic Planning Systems, 1977, pp. ix-xv.

2/ Ibid., pp. 139-150.

3/ Lynn H. Hall. Issues Management: Decision Support in the Context of Environmental Uncertainty, presentation at Chemical Marketing Research Association Meeting, Sept. 22, 1980.

4/ Ibid.

5/ Peter F. Drucker, Management: Tasks, Responsibilities, Practices, pp. 121-129.

assessment of the external variables can be produced. The determination of these factors gives the planner the information needed to provide an accurate and well developed strategy. 1/

The strategic planning function also needs to be a dynamic, on-going function, which changes as the competitive situation changes. In a rapidly changing world petrochemicals area, a plan developed even 2 or 3 years previously would bear no resemblance to a plan generated at the present time. 2/ Strategic planning for a producer of commodity petrochemicals also necessitates the knowledge of many related areas, such as petroleum refining on the upstream side, and specialty chemicals on the downstream side. Appreciation of key changes in any of the many related areas is extremely important in fine tuning strategic plans. 3/

Specific factors which need to be considered in preparation for a strategic planning exercise in the petrochemical industry are related to the main orientation of the firm being considered, be it a commodity petrochemical producer or a specialty chemical producer. 4/ More and more firms which had at one time strictly produced commodity petrochemicals are changing their orientation. This trend is seen by some analysts as a fundamental progression, rather than just a drive for higher levels of profitability. 5/ This progression is seen as a logical development from an ever-increasing need for improved performance from older products (a primary specialty chemical characteristic) and, in addition, a need for the development of new products. 6/

The availability of several distinct strategic avenues provides the U.S. chemical industry with multiple possibilities in terms of designing a tailor-made program for one particular company in a unique situation. Major U.S. commodity petrochemical producers have used one or more of these major routes in their attempt to regain levels of profitability currently unachievable by maintaining traditional business strategies for commodity petrochemicals. The three most common strategies now being employed by U.S. commodity petrochemical producers in the domestic market are: (1) rationalization; (2) diversification, either vertical, horizontal, or even geographic; and (3) seeking a niche within well-bounded commodity/specialty areas. 7/ However, other strategies which involve increasing interest in offshore production, licensing of proprietary technology to secondary users, and using the joint-venture avenue for entrance into new areas, thus allowing the risk for new projects to be absorbed by more than one firm, have also become increasingly common. In particular, U.S.-based producers with investments in commodity petrochemical capacity in CERN's are seen by many analysts as being

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1/ Karl Loos, "Strategic Planning in the Petrochemicals Industry," Strategic Planning and Energy Management, Fall 1984, pp. 39-49.

2/ Ibid.

3/ Peter F. Drucker, The Age of Discontinuity, 1969, pp. 3-42.

4/ Laszlo Unger, "Strategic Planning for Commodities and Specialties," Long Range Planning, Vol. 16, No. 4, 1983, pp. 12-20.

5/ Ibid.

6/ Ibid, p. 18.

7/ "How Old Strategies Now Are Changing," Chemical Week, Oct. 26, 1983, pp. 50-52.

in the most enviable position of all producers who have remained committed to retaining their commodity petrochemical orientation. 1/

Diversification

Geographic Diversification

Despite the rush by many smaller producers of commodity petrochemicals into areas of specialty chemical production, the large multinational corporations which have traditionally been the world's largest suppliers of commodity petrochemicals are expected to continue along with the same lines of production. Although price competition via cost cutting is expected to provide only very small profit levels, the quantities of material involved in these commodity markets could be large enough to make profits significant. Cost cutting in domestic facilities, where any further reductions can probably no longer be accomplished without directly affecting the operations of the facility in question, has reached its practical limits. 2/ Many of those U.S.-based companies remaining dedicated to world-scale production of commodity petrochemicals are availing themselves of the competitive advantages offered by the CERN's. The investments in these overseas facilities may be in the form of subsidiary development, joint ventures, or even marketing agreements in which these U.S. firms with sophisticated marketing networks already in place throughout the world offer these services in exchange for rights to invest in these nations' petrochemical facilities. 3/

Very few, if any, firms are limiting themselves to this one particular strategy. The one-strategy route, which was followed by many commodity petrochemical firms through the 1960's and early 1970's, led a number of these firms into extremely dangerous economic situations in the late 1970's and early 1980's. The volatile political nature of the developing countries within which such large hydrocarbon resources for feedstocks are located, makes the investments a significant risk. As mentioned previously,the involvement of many U.S.-based firms is through the joint venture approach, which allows the risk to be divided among several participants.

The relocation of production abroad, which may be considered a geographic diversification, is a costly strategy. 4/ The initial investment in many of the conventional energy-rich areas of the world to construct an efficient production facility and the necessary accompanying infrastructure may be two to three times the costs of building equivalent facilities in the continental United States. Dry climatic conditions prevalent in the Saudi desert or the cold winter temperature extremes in energy-rich areas in Canada necessitate physical adaptations built onto the facilities located in those regions. 5/

1/ Ibid.
2/ Ibid.
3/ Ibid.
4/ Ibid.
5/ "Saudi Chemicals: What Kind of Menace?," Chemical Business, September 1984, pp. 10-16.

These adaptations, which are not often included in the cost of U.S. facilities, along with the initial infrastructural development as necessary (now mostly completed in Saudi Arabia), make the decisions to geographically diversify initially very expensive. 1/

Among the consequences of such a plan is to place the domestic production facilities of a firm in direct competition with the same firm's offshore facilities. Options in situations where supply outstrips demand, as is the case in today's situation, include rationalization of facilities; in which the domestic facilities would in most cases be shut down in favor of more efficient offshore production facilities, which have the added advantage of readily available low-cost feedstocks. Some firms may also choose to compete in separate markets; for example, production from facilities located in the CERN's may be marketed only in areas of the world which are outside the traditional marketing areas of the U.S. facilities. Such a practice would in effect be making the success or failure of the new production facility dependent on its own ability to create new demand and compete successfully in newly developing markets.

Vertical Diversification

The major part of the movement from commodity petrochemical production into specialty chemicals, and in most cases the more successful segment of the trend, may be classified as vertical diversification. 2/ A number of the advocates of this philosophy have already proven themselves successful, particularly when their plans have been carefully set and followed through.

The direction of this strategy may be forward, backward, or in some cases may actually be in both directions. Company A, one particular major producer of commodity petrochemicals, most of which were polymers and resins which went into fibers, now has a far more diversified structure and scheme of production than it had previously. Figure 7 shows the difference in the structure of this company from 1973 to 1982, as the purchase of various smaller specialty companies provided an improved mix of chemical products through forward integration. A back-integrated purchase of an energy company further guaranteed a steady stream of feedstocks and a hedge against a future energy price shock. 3/

The path taken to acquire desired subsidiaries is not always smooth. Often unwanted or unneeded divisions either need to be absorbed or divested in order to achieve the strategic balance desired. Although the previous example (figure 7) showed a tremendous change in the overall strategic thrust of company A, the overall sales of the traditionally produced chemicals and chemical products varied only slightly (figure 8). The only segment which showed a decline in sales value during 1973-82 was the industrial chemicals

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1/ Ibid.

2/ "How Old Strategies Now Are Changing," Chemical Week, Oct. 26, 1983, pp. 50-52.

3/ "DuPont: With Conoco, A Split Personality?," Chemical Week, Oct. 26, 1983, pp. 52-53, and "DuPont Bets Its Future on Massive R. & D. Expansion," Chemical & Engineering News, Feb. 6, 1984, pp. 7-12.

FIGURE 7.—MERCHANDISE: U.S. IMPORTS, EXPORTS, AND TRADE DEFICIT, 1977–83

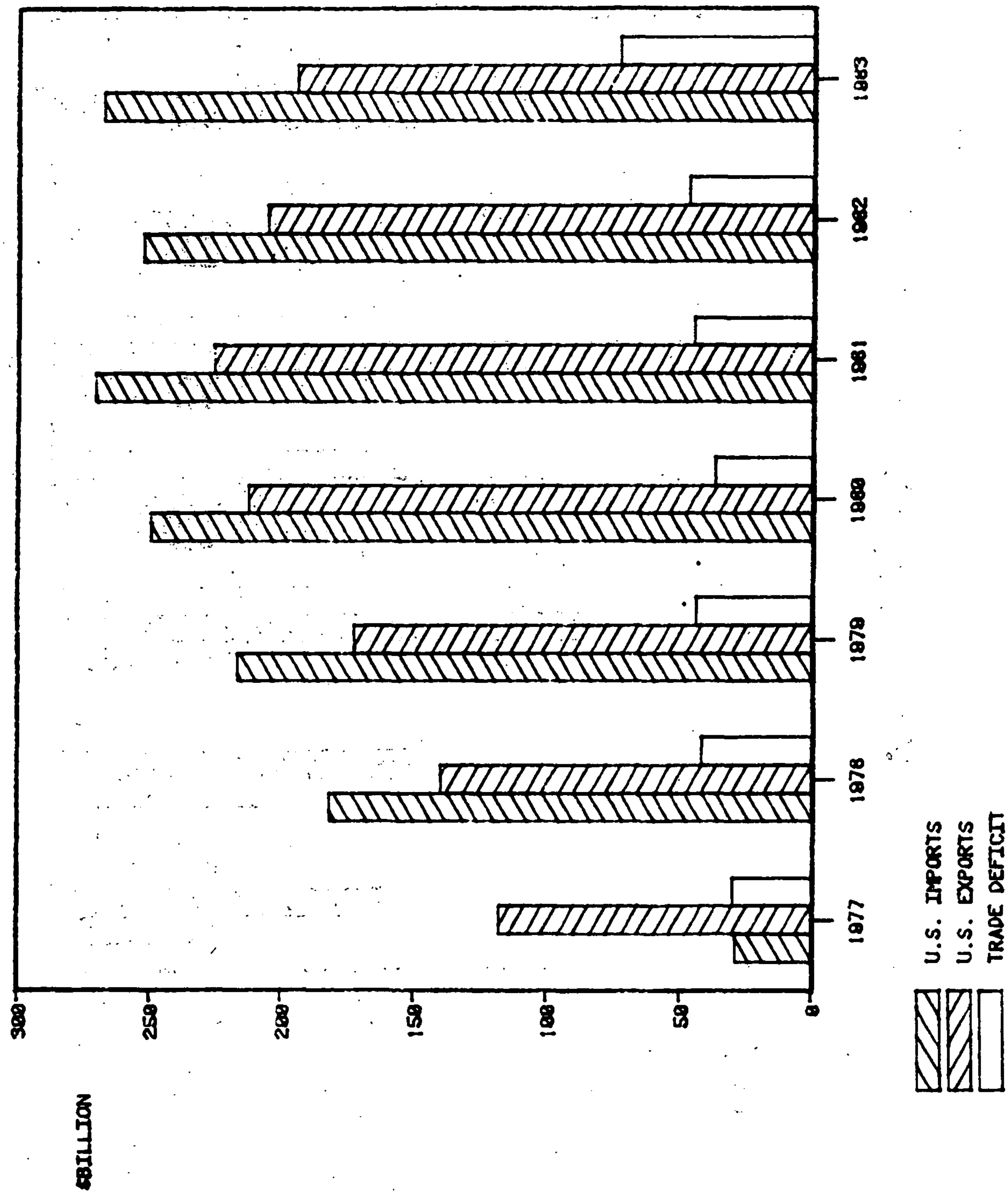
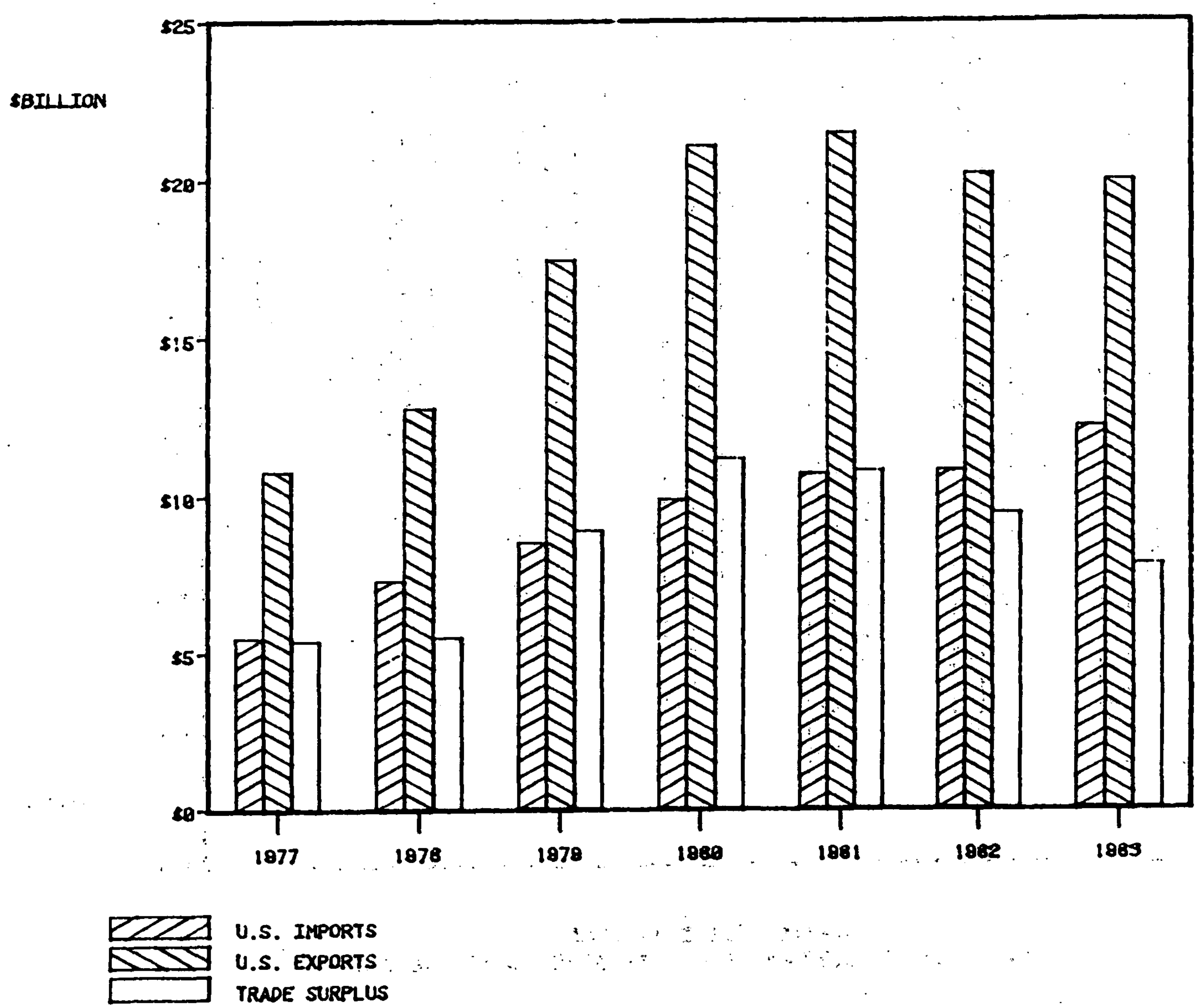


FIGURE 8.—CHEMICALS: U.S. IMPORTS, EXPORTS, AND TRADE SURPLUS, 1977-83



area. In this case, the statistics may be misleading, as more industrial chemicals may have been used internally in operations to produce various other value-added products such as specialty chemicals or chemical products. 1/

Another important U.S. force in commodity petrochemicals, Company B, has already completed the first phase of its divestiture of a sizable portion of its commodity petrochemicals operations in favor of value-added specialty chemicals. 2/ This firm is rapidly becoming the model company most often cited for strategic moves of this nature. The following tabulation shows the allocation of Company B's fixed assets as of 1975, and 1983, and a projection for 1985 (in percent): 3/

	1975	1983	1985
Commodity petrochemicals--------	43	15	11
Specialty petrochemicals--------	13	27	29
Non-petrochemicals--------------	44	58	60

Changes seen during 1975-83 include lessened involvement with commodities such as basic plastics and raw materials for polyester fibers, and increased investments in pharmaceuticals and specialty chemical food ingredients. Looking toward the future, Company B is working together with buyers of its specialty chemicals to refine the chemical's characteristics to better meet the buyers needs, and is also now looking to invest in horizontally diverse businesses. 4/

Horizontal Diversification

The main concept behind horizontal diversification is the spreading of one's reach into nonrelated areas of business. For example, Company C at one time a vertically integrated producer of petrochemicals and their downstream chemical products, has now spread into a multitude of other interests. 5/ Figure 9 shows the change in strategic balance between the former chemical orientation of this firm and its current diversified strategic array of business endeavors.

The chairman of the board of Company C reaffirmed his belief that --

> U.S. companies will have to commit themselves "much more seriously" to programs of efficiency improvements, diversification, and new product development. 6/

1/ Ibid.

2/ "Big Gains at Hercules Reflect a Major Shift by Chemical Firms to 'Specialty Products'," Wall Street Journal, Nov. 19, 1983.

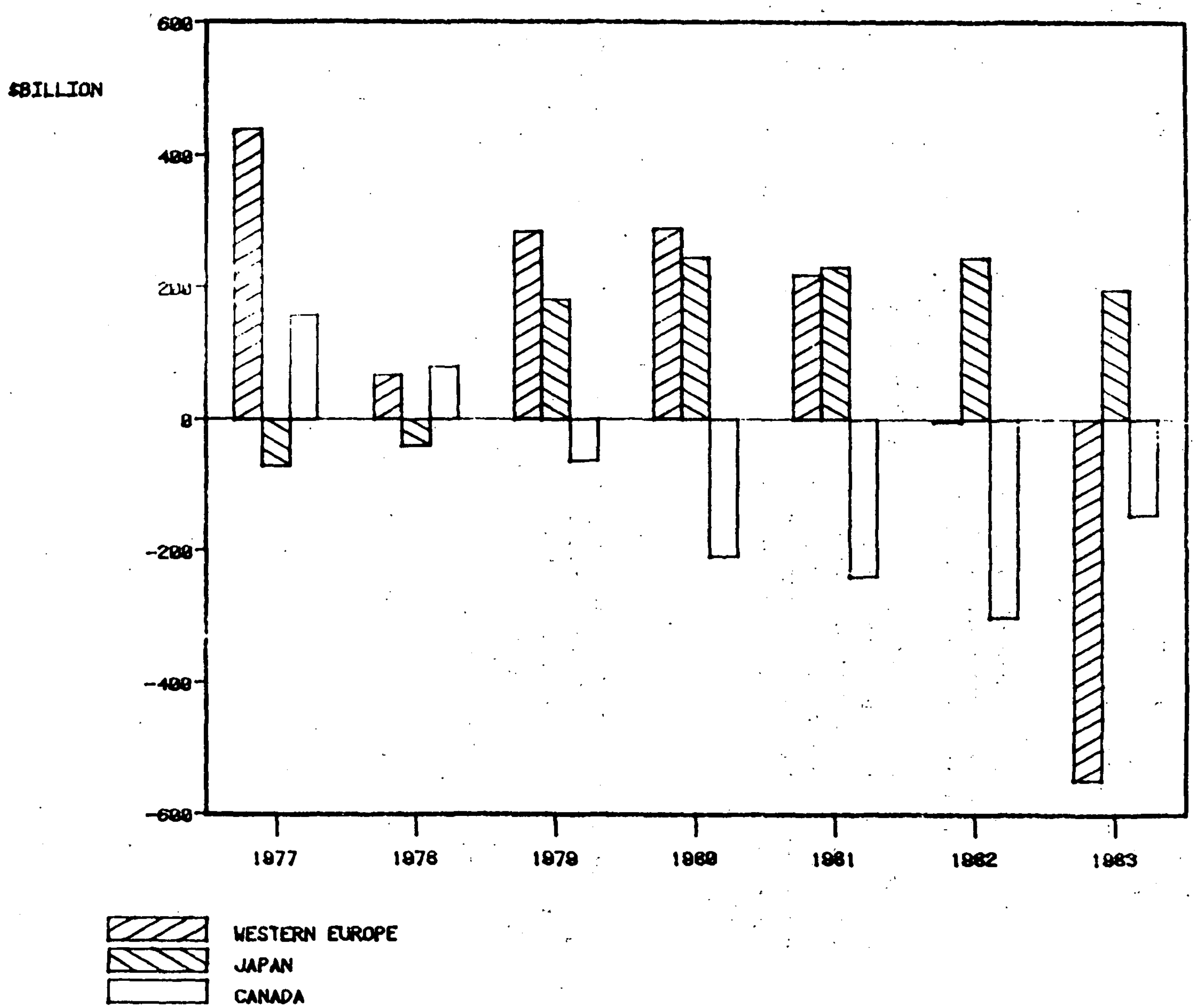
3/ Ibid.

4/ Ibid.

5/ "Allied Chemical Focus Losses Out to 'Balance'," Chemical Week, Oct. 26, 1983, pp. 53-53.

6/ "Allied's Hennessy Prescibes Dose of 'Serious' Commitment," Chemical Marketing Reporter, Apr. 9, 1984, pp. 5 and 32.

FIGURE 9.--ORGANIC CHEMICALS: U.S. BALANCE OF TRADE WITH COMMODITY PETROCHEMICAL PRODUCING AREAS, 1977-83



This statement, made at the National Petroleum Refiners Association Convention in May 1984, continued the theme that strategic use of resources would be needed for the U.S. petrochemical industry in particular, and, more generally, all U.S. industry, to fare better in the international marketplace. 1/ His statement also contained direct references to the commodity petrochemical producers in the United States--"rationalize to improve operating efficiency and cut costs and diversify (horizontally) to improve the product base." 1/

Figure 10 gives an indication of how successful the strategy employed by Company C has been. Despite the rationalization of commodity petrochemical capacity, actual values of production for sectors in 1982 exceeded the values for those same sectors which had been a part of Company C's organization in 1973. These sectors, now representing only a portion of the firms sales, share the overall production plan with new large segments of the firm devoted to a variety of different pursuits. 2/

Other Strategies

U.S. commodity petrochemical producers who have already settled into one or more specialty chemicals markets 3/ and have established respected technology and product bases are able to make use of two other prominent strategies to improve their profit picture. One of these strategies involves licensing of their technology to other producers. This practise has occurred primarily with producers located in the traditional petrochemical-producing nations licensing their technology to those locating their production facilities in CERN's. Although at one time firms would be tempted to use their own most advanced technological processes to their own advantage, and license outdated technology to developing nations, the petrochemical industry technology licensed to producers in CERN's is the most advanced, state-of-the-art technology available anywhere. 4/

Certain U.S.-based companies have set goals to license as much of their technology as possible to producers taking advantage of locations in CERN's. The primary markets of licensors are the Middle East, the Far East, and Canada. 5/ An example is Company D, which has developed proprietary technology for production of such items as specialty grades of commodity plastics resins, tailored specifically for uses by the licensor and the company purchasing the material for incorporation into a certain product.

1/ Ibid., p. 32.

2/ "Allied: Chemical Focus Loses Out to 'Balance'," Chemical Week, Oct. 26, 1983, pp. 53-54.

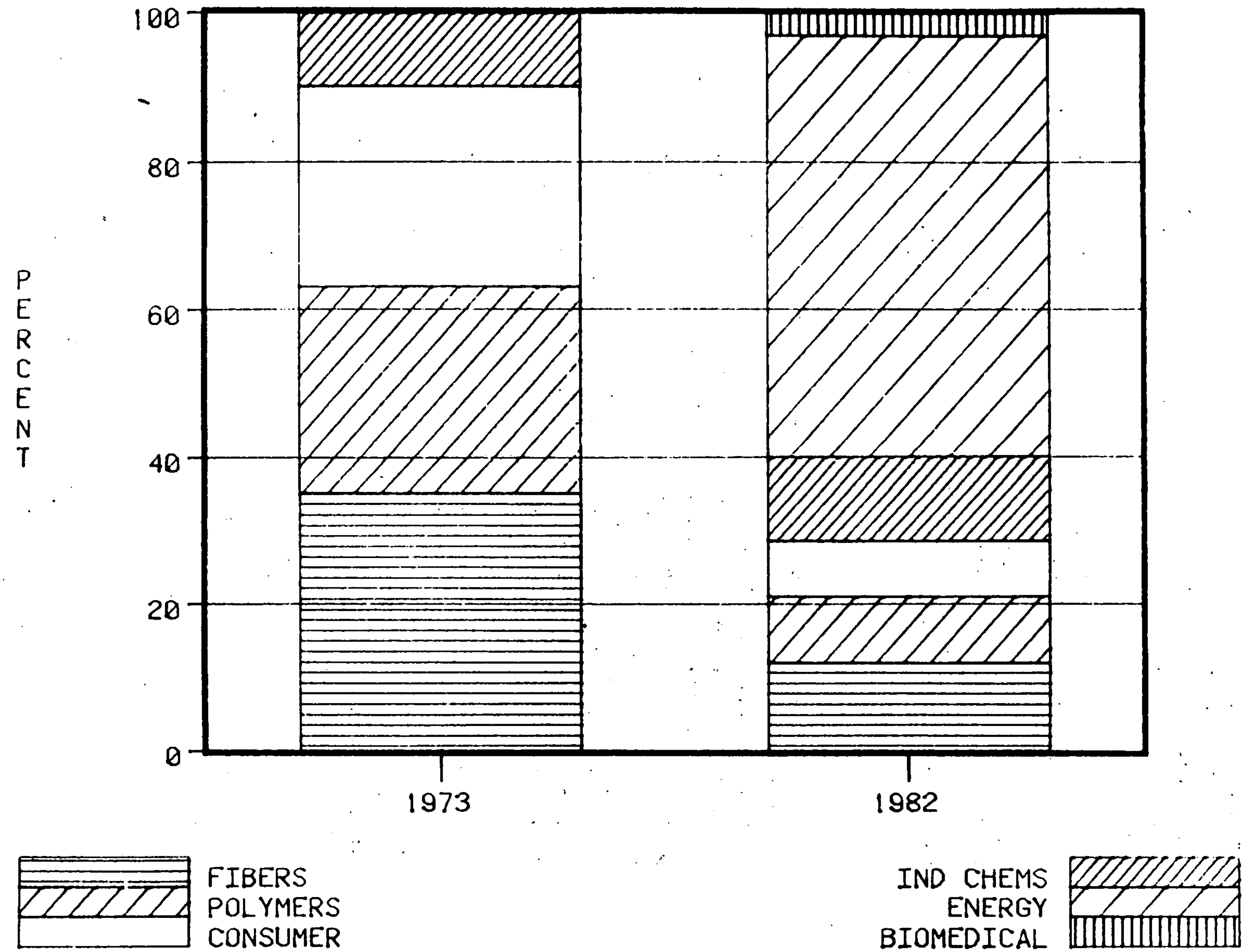
3/ In this case, the specialty chemicals market may also include certain specific specialty grades of commodity petrochemicals. These commodity petrochemicals may be considered specialties because of the proprietary nature of the processes used in their manufacture and/or specifically engineered qualities or the special nature of the product material.

4/ Office of Technology Assessment, Technology Transfer to the Middle East, September 1984, pp. 117-182.

5/ Much of the development in Canada is sponsored by Canadian subsidiaries of the U.S. licensors, thus changing the structure of the licensing agreements.

FIGURE 10.--SHARE OF SALES OF PRODUCT LINES

BY COMPANY "A"



This company had begun a program to rationalize capacity in commodity petrochemicals early on, so that by 1979, commodity petrochemicals and plastics accounted for only 37 percent of the company's $7.9 billion of sales. 1/ In 1979, this company targeted six particular areas which, if strategic goals would be met, would account for 75 percent of all Company D's assets in 1983. 2/ Also in 1979, Company D launched the licensing program 3/ which allowed a producer of low-density polyethylene to reduce his capital costs for a new plant by two-thirds and also reduce energy costs by 85 percent. 4/ One petrochemical industry analyst projects Company D's 1984 income from licensing this technology will be about $81 million.

The specialty nature of the industry may be a service which can accompany the licensing of technology, such as the use of the licensors' marketing service. A Canadian licensee's new ethylene facility which began production in 1984 based on natural gas feedstocks and Company D's technology will be using Company D's marketing service. As of 1984, no other firm had commercialized this type of service. 5/

The major risks taken by the licensor either involve the breaking of the licensing agreement or the penetration of the licensor's domestic market by the licensee. 6/ In the case of petrochemical engineering technology, however, since the technology provided is state of the art and the resulting production is priced competitively on the world market (some say too competitively), there is no incentive for the licensee to violate the terms or to take unfair advantage of the licensing agreement.

The desire to maintain good international trade relations is the main motivating force behind the prevention of nonorderly marketing of the licensee's product. Although Company D freely licenses its technology to all who are willing to pay for it, fears of license agreement violations cause other firms to be more selective about their partners in these agreements. 7/

The other prominent strategy employed as often as possible by companies which produce specialty chemicals is the specialty equivalent of a commodity "cash cow." This would entail the development of a product which, through its unique set of properties, could be depended upon to generate revenue for the development of new products. This strategy, which is the ultimate goal of most any specialty chemical company, especially if it is independent and has no uninterruptible source of funding for R. & D., 8/ is attained through the development of a proprietary position. A proprietary position in specialty

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1/ "Union Carbide: Its Six-Business Strategy Is Light on Chemicals," Business Week, Sept. 24, 1979, pp. 97-100, and "Union Carbide: Battling Slow Growth by Licensing Technology," Business Week, Sept. 19, 1983, p. 88.

2/ "Union Carbide: Its Six-Business Strategy Is Light on Chemicals," Business Week, Sept. 24, 1979, pp. 97-100.

3/ Unipol.

4/ "Union Carbide: Battling Slow Growth by Licensing Technology," Business Week, Sept. 19, 1983, p. 88.

5/ Ibid.

6/ Office of Technology Assessment, op.cit., p. 147.

7/ Office of Technology Assessment, op.cit.

8/ As mentioned previously, the backbone of any specialty chemical operation.

chemicals is significantly different from a proprietary position in commodities. In the specialty chemicals area, it may be inferred that no other producer has a similar product. In the commodity petrochemicals area, it is far more likely to be only the "process" 1/ that is proprietary. 2/ The majority of successful specialty chemical manufacturers have attained this strategic goal with at least one area or product.

1/ Company D licensed technology related to production of a specialty grade of a commodity petrochemical, not a real commodity.

2/ "Chemical Specialties," Presentation by Richard A. Andrews at Conference on Strategic Planning for Petrochemicals, Sept. 11, 1984.

WORLD TRADE PATTERNS

Overview

The net trade balance for all merchandise trade from the traditional commodity petrochemical-producing areas is shown in table 10, and the net trade balance for chemicals is shown in table 11. Both the chemical trade pattern and the overall merchandise trade pattern seen for each of these traditional commodity petrochemical producers is as different as the respective producer's petrochemical industries is different (discussed in greater detail in a previous section).

The U.S. net trade deficit for all merchandise 1/ has become progressively larger during 1977-83, whereas the Western European 2/ trade deficit has, since 1980, grown increasingly smaller. The Japanese trade balance only twice registered deficits during 1977-83 and, in 1983, reached its largest trade surplus during that period.

Throughout this period, Western European traders consistently had trade deficits with all of their major trading partners. Japanese traders had large surpluses with Western European and U.S. partners, and trade deficits with their major sources for energy materials/petrochemical feedstocks, particularly Canada and Middle East CERN's. The following tabulation shows the Japanese merchandise trade balances with these two areas during 1977-83 (in millions of dollars): 3/

Year	Canada	Middle East CERN's
1977	-1,172	-12,228
1978	-1,311	-10,728
1979	-2,345	-19,473
1980	-2,285	-30,902
1981	-1,063	-26,406
1982	-1,573	-21,800
1983	-751	-17,934

These figures highlight the extent to which Japanese consumers depend on imported sources of energy. The following tabulation shows the Japanese trade balances for petroleum and natural gas during 1983 with its major trading partners (in millions of dollars). 1/

1/ All trade balances are in terms of U.S. dollars.

2/ Western European trade balance is the sum of the trade balances of the individual nations in Western Europe.

3/ Compiled from official statistics of the UN Trade Data System.

Table 11.--Chemicals: Net trade balance as reported by traditional commodity petrochemical producers, 1972-1983

(In millions of dollars)

Partner	United States	Western Europe	Japan
United States:			
1972	-	-897	-167
1977	-	-1,632	-681
1978	-	-1,892	-834
1979	-	-3,305	-1,432
1980	-	-3,648	-1,799
1981	-	-3,048	-1,832
1982	-	-2,331	-2,171
1983	-	-539	-2,157
Western Europe:			
1972	509	-	-251
1977	1,165	-	-628
1978	886	-	-939
1979	1,978	-	-1,194
1980	2,381	-	-1,192
1981	2,217	-	-1,201
1982	1,732	-	-1,362
1983	727	-	-1,457
Japan:			
1972	63	151	-
1977	480	429	-
1978	501	696	-
1979	978	880	-
1980	1,240	782	-
1981	1,386	830	-
1982	1,634	949	-
1983	1,450	1,116	-
Canada:			
1972	253	53	-15
1977	213	235	-38
1978	-45	180	-53
1979	-445	179	-57
1980	-422	16	-116
1981	-480	70	-133
1982	-568	70	-132
1983	-6	171	-136
Non-market economies:			
1972	15	670	228
1977	36	1,861	521
1978	-2	2,347	629
1979	139	2,388	613
1980	115	3,799	752
1981	402	3,117	589
1982	546	2,205	552
1983	293	2,125	581
Total:			
1972	2,118	2,753	636
1977	5,357	8,568	1,296
1978	5,483	11,934	1,304
1979	8,949	12,096	891
1980	11,199	14,611	528
1981	10,788	14,646	317
1982	9,423	14,135	-492
1983	7,822	18,657	-254

Source: Based on official statistics of the U.N. Trade Data System.

Table 10.--Merchandise: Net trade balance as reported by traditional commodity petrochemical producers, 1972-1983

(In millions of dollars)

Partner	United States	Western Europe	Japan
United States:			
1972	-	-917	3,113
1977	-	-9,290	7,507
1978	-	-8,468	10,307
1979	-	-16,486	6,132
1980	-	-30,905	7,201
1981	-	-20,273	13,553
1982	-	-16,119	12,380
1983	-	-2,966	18,546
Western Europe:			
1972	-298	-	2,324
1977	5,232	-	7,898
1978	1,205	-	7,456
1979	5,382	-	7,096
1980	15,523	-	11,915
1981	6,578	-	14,376
1982	2,220	-	12,791
1983	-2,952	-	13,522
Japan:			
1972	-4,140	-2,187	-
1977	-8,480	-9,276	-
1978	-13,811	-9,292	-
1979	-10,812	-9,934	-
1980	-12,399	-15,708	-
1981	-18,527	-16,290	-
1982	-19,534	-16,068	-
1983	-22,333	-15,112	-
Canada:			
1972	-2,826	-624	-44
1977	-4,748	-1,540	-1,172
1978	-6,866	-951	-1,311
1979	-7,161	-2,361	-2,345
1980	-8,217	-4,376	-2,285
1981	-8,337	-2,801	-1,063
1982	-13,921	-2,297	-1,573
1983	-15,906	-706	-751
Non-market economies:			
1972	526	498	121
1977	1,581	719	1,895
1978	2,797	1,883	2,927
1979	5,286	-2,925	2,050
1980	4,942	-7,034	2,586
1981	4,127	-6,845	2,438
1982	2,874	-10,559	1,349
1983	1,116	-8,451	-2,045
Total:			
1972	-6,584	-10,235	5,120
1977	-29,936	-39,749	9,909
1978	-42,192	-24,060	18,770
1979	-43,728	-61,479	-7,143
1980	-37,393	-108,909	-10,349
1981	-45,436	-66,850	11,079
1982	-46,988	-55,472	8,265
1983	-73,350	-17,923	21,786

Source: Based on official statistics of the U.N. Trade Data System.

Partner	Crude petroleum	Petroleum products	Natural gas
United States	0	-703	-412
Western Europe	0	-10	-74
Canada	-39	-3	-81
Mexico	-1,453	0	0
Middle East CERN's	-27,819	-2,055	-3,045
Non-market economies	-2,088	-611	-1
All other	-8,263	-2,413	-4,718
Total	-39,662	-5,794	-8,331

Not only does the actual drain on hard currency caused by the energy/feedstock material trade deficit negatively impact the Japanese economy, but the vulnerability to supply disruptions plays a significant role in the determinations of Japanese industrial development. The Western European situation is somewhat similar, although the North Sea area's production of crude petroleum and natural gas is proving to be a valuable supplement to imports of these materials. The following tabulation shows the Western European trade balance for 1983 in these two energy/feedstock materials (in millions of dollars): 1/

Partner	Crude petroleum	Petroleum products	Natural gas
United States	4,117	64	-6
Japan	0	13	46
Canada	180	13	0
Mexico	-1,864	-23	0
Middle East CERN's	-25,403	-1,896	-164
Non-market economies	-7,558	-9,546	-2,078
All other	-26,462	313	-9,192
Total	-55,799	-11,793	-8,632

Despite the positive trade balance with the United States, Canada, and Japan for 1983, the Western European industrial consumers need to continue both rationalization and energy conservation programs so that increasing demand does not create a deeper trade deficit for these items in coming years.

The trade balance for chemicals from Western European nations has consistently been a positive contributing force toward the overall merchandise trade balance, increasing from a surplus of $2.1 billion in 1979 to $18.7 billion in 1983 (table 11). The following tabulation shows the 1983 chemicals

1/ Compiled from official statistics of the UN Trade Data System.

trade balance position of Western Europe with its major trading partners (in millions of dollars). 1/

Partners	Trade balance
United States	-539
Japan	1,116
Canada	171
Mexico	204
Middle East CERN's	3,672
Non-market economies	2,125
All other	9,353
Total	18,657

This overall Western European chemical trade surplus needs to be maintained and increased in order to restore more profitable levels of operations in these nations which depend so heavily on the chemical export market.

The program of rationalization engineered by the Japanese MITI, taking into consideration the virtual absence of a domestic feedstock base, has enabled the Japanese chemical industry to accept a negative overall trade balance for chemicals (table 11). This situation, resulting from imports of some petrochemical building blocks, has allowed the Japanese industry to concentrate their attention on improving value-added chemical production.

U.S. Trade

The U.S. merchandise trade balance 2/ has been steadily declining during 1977-83; the trade deficit increased from $29.9 billion in 1977 to nearly $73.4 billion in 1983 (figure 11). However, trade in chemicals has consistently been a major contributing factor on the positive side, as the U.S. trade surplus for chemicals increased from $5.4 billion in 1977 to $11.2 billion in 1980. The U.S. chemicals trade surplus leveled off to $7.8 billion in 1983, as the industry reacted to the worldwide economic slowdown and increased commodity petrochemical capacity which came onstream in CERN's during 1980-82. During 1980-83, there was a significant decline in worldwide demand for almost all merchandise brought about by the economic slowdown. This is reflected in declining export values for the United States during 1981-83, both for chemicals and all commodities (tables 12 and 13).

U.S. Merchandise Trade

U.S. imports and exports of all merchandise traded are shown in table 14; U.S. imports and exports of chemicals are shown in table 15. Individual

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1/ Compiled from official statistics of the UN Trade Data System.

2/ Trade data as reported to the United Nations for inclusion in the U.N. Trade Data System are used in this section instead of official statistics of the U.S. Department of Commerce wherever possible, so that comparisons with other nations trade patterns are possible and statistically valid.

FIGURE 11.--VALUE OF SALES OF PRODUCT LINES

BY COMPANY "A"

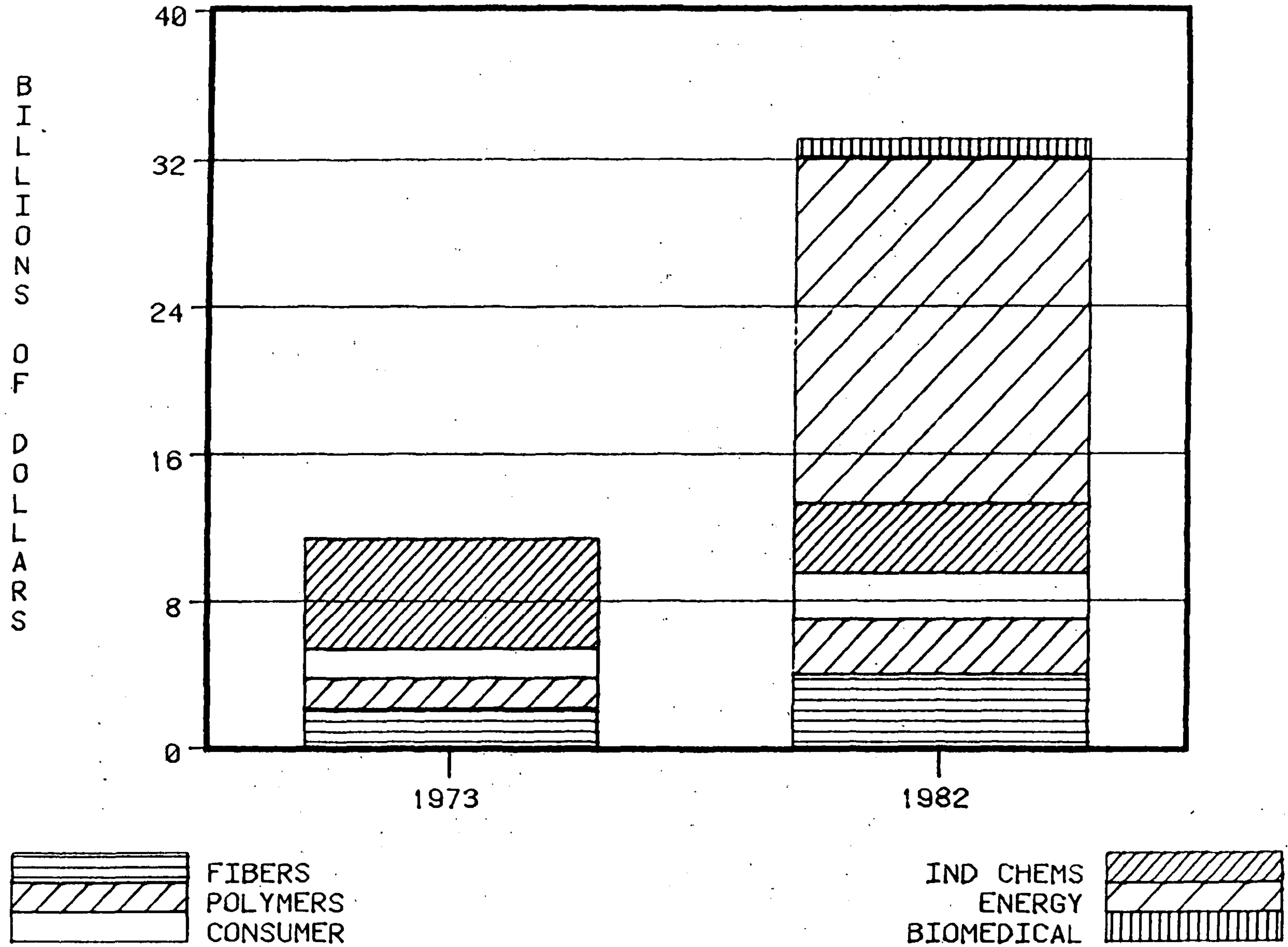

Table 12.--Merchandise: Exports from traditional petrochemical producing areas, 1970-83

(In millions of dollars)

Year	United States	Western Europe	Japan
1970	42,590	45,146	19,319
1971	43,491	51,052	24,018
1972	48,978	59,354	28,591
1973	70,245	79,470	36,931
1974	97,144	110,990	55,537
1975	106,102	127,123	55,754
1976	113,318	132,906	67,202
1977	117,926	157,590	80,470
1978	140,002	191,311	97,501
1979	173,657	220,441	102,964
1980	212,887	257,685	129,542
1981	225,776	269,423	151,910
1982	206,044	254,135	138,584
1983	194,620	234,005	146,803

Source: Compiled from official statistics of the U.N. Trade Data System.

Table 13.--Chemicals: Exports from traditional petrochemical producing areas, 1970-83

(In millions of dollars)

Year	United States	Western Europe	Japan
1970	3,825	44,889	1,234
1971	3,835	5,350	1,488
1972	4,132	6,317	1,784
1973	5,749	8,855	2,148
1974	8,819	14,784	4,066
1975	8,691	13,950	3,885
1976	9,958	14,855	3,746
1977	10,816	17,446	4,298
1978	12,806	21,800	5,066
1979	17,465	26,051	6,067
1980	21,076	31,123	6,729
1981	21,487	30,262	6,801
1982	20,211	28,331	6,329
1983	19,994	28,938	6,949

Source: Compiled from official statistics of the U.N. Trade Data System.

Table 14.--Merchandise: U.S. imports and exports to major trading partners, 1963, 1967, 1972, and 1977-83, and estimated growth rates 1979-83

Flow of Trade Year	OECD	WESTERN EUROPE	JAPAN	TRAD.PETR.PROD.	WORLD
Imports					
1963	10,468,161 T	4,703,157 T	1,494,359 T	6,197,516 T	17,013,747 T
1967	18,643,813 T	8,067,720 T	2,998,663 T	11,066,383 T	26,815,636 T
1972	40,337,279 T	15,434,735 T	9,067,576 T	24,502,311 T	55,563,365 T
1977	77,679,853 T	27,826,662 T	18,900,405 T	46,727,067 T	147,862,419 T
1979	113,487,419 T	44,198,084 T	28,141,355 T	72,339,439 T	217,386,631 T
1980	124,858,378 T	48,130,973 T	32,856,970 T	80,987,943 T	250,280,367 T
1981	142,644,602 T	54,217,822 T	39,844,958 T	94,062,780 T	271,212,676 T
1982	143,226,309 T	54,635,294 T	39,896,644 T	94,531,938 T	253,033,059 T
1983	154,072,950 T	56,174,894 T	43,519,248 T	99,694,142 T	267,971,001 T
EPGR 79-83	7.94 %	6.18 %	11.52 %	8.35 %	5.37 %
Exports					
1963	12,910,661 T	6,814,189 T	1,686,919 T	8,501,107 T	22,921,717 T
1967	19,930,920 T	9,446,103 T	2,635,422 T	12,081,525 T	31,147,223 T
1972	32,929,497 T	15,136,342 T	4,927,568 T	20,063,909 T	48,978,610 T
1977	70,818,736 T	33,058,929 T	10,419,446 T	43,478,376 T	117,926,385 T
1979	101,454,888 T	49,580,449 T	17,328,843 T	66,909,292 T	173,657,713 T
1980	120,458,447 T	63,654,804 T	20,457,403 T	84,112,207 T	212,887,037 T
1981	124,538,632 T	60,796,757 T	21,317,608 T	82,114,364 T	225,776,517 T
1982	113,614,538 T	56,855,890 T	20,362,375 T	77,218,265 T	206,044,717 T
1983	113,838,059 T	53,222,149 T	21,186,208 T	74,408,356 T	194,620,384 T
EPGR 79-83	2.92 %	1.79 %	5.15 %	2.69 %	2.89 %

Source: Compiled from official statistics of U.N. Trade Data System.

Table 15.--Chemicals: U.S. imports and exports to major trading partners, 1963, 1967, 1972, and 1977-83, and estimated growth rates 1979-83

Flow of Trade Year	OECD	WESTERN EUROPE	JAPAN	TRAD.PETR.PROD.	WORLD
Imports					
1963	446,154 T	244,083 T	33,205 T	277,287 T	566,468 T
1967	784,218 T	416,044 T	69,621 T	485,666 T	963,069 T
1972	1,722,156 T	939,964 T	250,294 T	1,190,258 T	2,014,594 T
1977	4,785,443 T	2,573,310 T	494,259 T	3,067,569 T	5,458,367 T
1979	7,437,202 T	3,679,029 T	670,782 T	4,349,811 T	8,516,654 T
1980	8,405,034 T	4,162,619 T	748,811 T	4,911,430 T	9,876,597 T
1981	8,979,119 T	4,151,853 T	997,616 T	5,149,469 T	10,699,371 T
1982	9,070,953 T	4,399,200 T	924,041 T	5,323,241 T	10,787,947 T
1983	9,840,673 T	5,284,333 T	1,170,274 T	6,454,607 T	12,171,869 T
EPGR 79-83	7.25 %	9.47 %	14.93 %	10.37 %	9.34 %
Exports					
1963	1,171,371 T	656,971 T	157,258 T	814,229 T	1,942,525 T
1967	1,662,070 T	929,155 T	226,863 T	1,156,018 T	2,802,523 T
1972	2,568,595 T	1,448,996 T	313,992 T	1,762,988 T	4,132,819 T
1977	6,607,212 T	3,738,616 T	975,240 T	4,713,855 T	10,816,094 T
1979	9,884,781 T	5,657,635 T	1,649,695 T	7,307,329 T	17,465,767 T
1980	11,321,806 T	6,544,579 T	1,989,222 T	8,533,801 T	21,076,225 T
1981	11,992,331 T	6,369,691 T	2,384,211 T	8,753,902 T	21,487,924 T
1982	11,523,280 T	6,131,345 T	2,558,381 T	8,689,726 T	20,211,843 T
1983	11,862,890 T	6,012,147 T	2,620,390 T	8,632,537 T	19,994,649 T
EPGR 79-83	4.67 %	1.53 %	12.26 %	4.25 %	3.44 %

Source: Compiled from official statistics of U.N. Trade Data System.

NOTE: Trad. Petr. Prod. are the traditional petrochemical producing areas of the world in addition to the United States--Western Europe and Japan. These areas are also members of the OECD, the Organization for Economic Cooperation and Development.

trading partners examined in these tables are the OECD, Western Europe, and Japan. 1/

Imports of merchandise

Chemicals have represented an increasing share of the imports of all commodities during 1963-83, increasing from 3.3 percent of the total value of all commodity imports in 1963 to 4.5 percent of the total in 1983. Imports of all commodities climbed from a value of $17.0 billion in 1963 to $267.9 billion in 1983. The overall increase in the value of merchandise imports from 1963 to 1983 was about 1,476 percent, or an average annual increase of about 15 percent. 2/

Unlike merchandise imports from all sources, U.S. imports of merchandise from the OECD increased from about $10.5 billion in 1963 to about $154 billion in 1983, or by more than 1,367 percent, an average annual increase of about 14 percent. The OECD's share of U.S. merchandise imports increased from about 61.5 percent in 1963 to about 72.6 percent in 1972; however, from 1977 to 1983, the OECD's share of these imports only ranged from about 50 percent of the total, in 1980, to about 58 percent of the total, in 1983.

Western Europe's share of U.S. merchandise imports also increased during 1963-83, from about $4.7 billion in 1963 to about $56.2 billion in 1983, or by approximately 1,200 percent, an average annual growth rate of 13 percent. The Western European share of U.S. merchandise trade ranged from 25 to 30 percent during 1963-1972. However, during 1977-83, the Western European share of these merchandise imports declined, ranging from 18 to 21 percent.

Imports of merchandise from Japan have also increased, from a value of $1.5 billion in 1962 to $43.5 billion in 1983. During 1979-83, the average annual growth rate was approximately 11.5 percent. These merchandise imports from Japan have accounted for between 12 and 16 percent of all merchandise imports throughout the major part of this period.

Exports of merchandise

During 1963-83, the share of U.S. merchandise exports represented by chemicals ranged from 8.4 percent (1972) to 10.3 percent (1983) of the value of all merchandise exports (tables 14 and 15). U.S. merchandise exports increased from $22.9 billion in 1963 to $194.6 billion in 1983. The value of U.S. exports of all commodities increased by about 750 percent from 1963 to 1983, or at an average annual rate of approximately 11 percent.

1/ The sum of trade for Western Europe and Japan is also included under the heading "Traditional Petroleum Products."

2/ Any shift in the sectoral production of chemicals would be expected to have effects throughout the industrial economy. Such items as plastics amd other chemical industry products are used in the manufacture of products from almost all other sectors of the U.S. industrial economy.

The value of U.S. merchandise exports to the OECD increased from $12.9 billion in 1963 to $113.8 billion in 1983, while the value of U.S. merchandise exports to Western European nations increased from $6.8 billion in 1963 to $53.2 billion in 1983. During 1979-83, the growth in exports to OECD nations slowed considerably, increasing at an average annual rate of only 2.9 percent. The rate of increase in the value of merchandise exports to Western Europe also declined during 1979-83, increasing only from $49.6 billion to $53.2 billion, or at an average annual rate of 1.8 percent.

The value of U.S. merchandise exports to Japan increased at a faster rate than OECD or Western European exports during 1979-83, increasing by an average annual rate of 5.2 percent. This rate of increase is more related to increasing Japanese rationalization than to increased demand. Japanese-bound exports increased overall from a value of $1.7 billion in 1963 to $21.2 billion in 1983.

U.S. Chemical Trade

U.S. chemical exports increased from $17.5 billion in 1979 to $21.5 billion in 1981, then declined to $20.0 billion in 1983 (table 15). The average annual growth rate through this entire period was more than 3.4 percent (figure 12).

Industry sources report that several factors have contributed to the recent trend of decreasing U.S. exports of chemicals. 1/ First, the strength of the U.S. dollar relative to other major currencies has generally made U.S. chemicals more costly than the foreign-made counterparts. On a trade-weighted basis, the dollar appreciated 50 percent during 1980-83. Therefore, foreign markets generally opted for foreign-made chemicals in many instances, especially where price was the major consideration. Second, most of the industrialized world did not enjoy the same degree of economic recovery in 1983 as did the United States. This restrained the foreign markets from regaining demand to the same extent as the U.S. market; also, as foreign chemical producers were trying to operate near capacity, their prices to domestic consumers seemed even more attractive. 2/ Additionally, U.S. chemical exports, especially ethylene-derived commodity petrochemicals, faced competition for foreign markets from such energy-rich sources as Canada,

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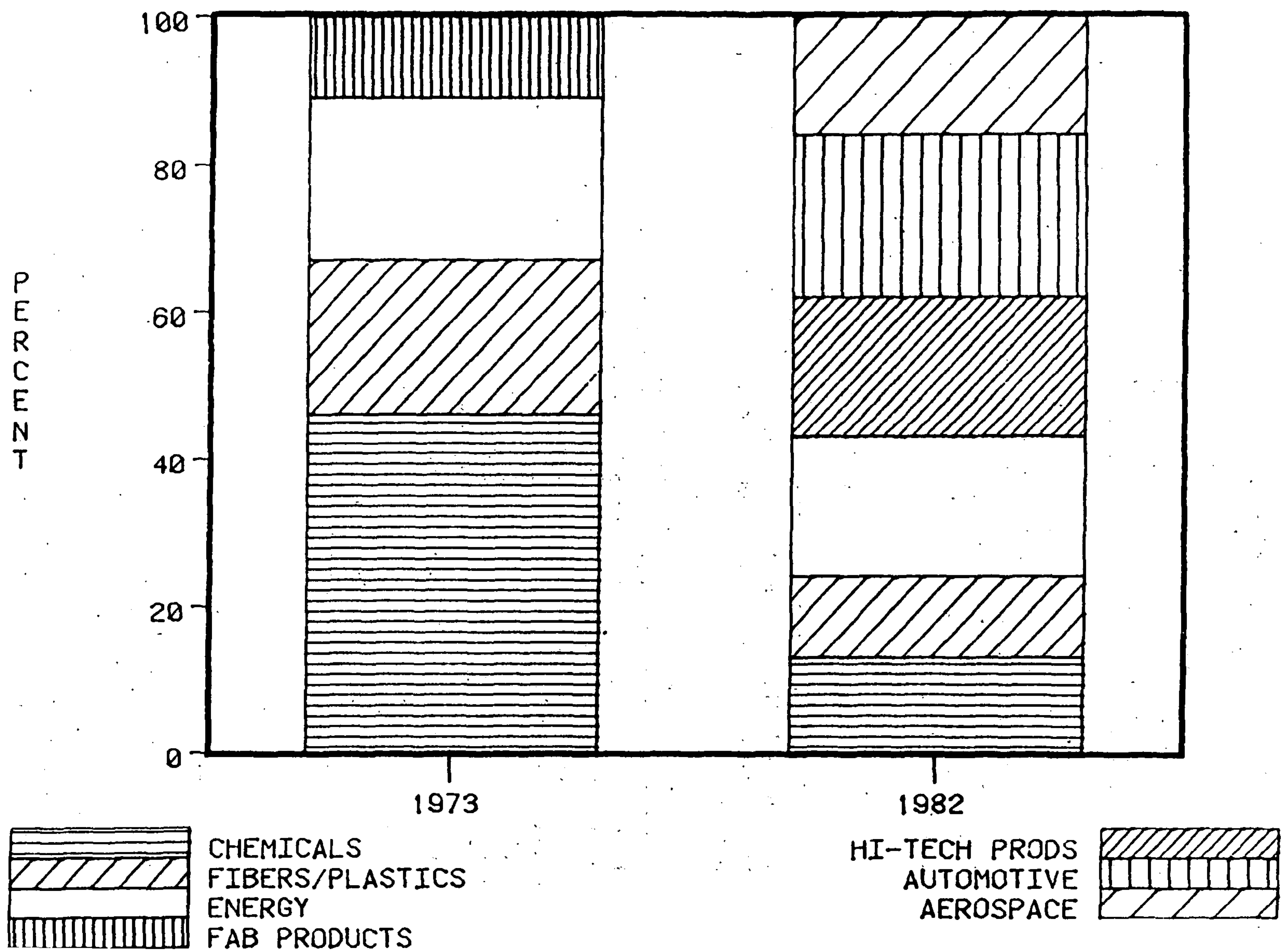
1/ "A Big Trade Setback for U.S. Producers," Chemical Week, Feb. 29, 1984, pp. 24-27; and, "U.S. Surplus in Chemical Trade Narrows Again As Exports Drop," Chemical & Engineering News, Dec. 19, 1983, pp. 27 and 29.

2/ "Chemical Trade Squabbles: The Industry is Divided Over Protectionism," Chemical Week, Mar. 28, 1984, pp. 34-39; "Chemicals and Materials 1983 Review/1984 Forecast," Elastomerics, February 1984, pp. 13-19; "U.S. Chemical Industry's 1984 Outlook," Hydrocarbon Processing, January 1984, p. 21; "CMA's Foveaux Sees Reason to Smile as Chemical Results Keep Looking Strong," Chemical Marketing Reporter, Dec. 19, 1983, pp. 3 and 24; and, "The Chemical Trade Balance Still Narrow," Chemical Week, Nov. 30, 1983, pp. 14 and 15.

FIGURE 12.--SHARE OF SALES OF PRODUCT LINES

BY COMPANY "B"



Mexico, and Saudi Arabia. 1/ This competition could intensify in the period through 1990, as additional plants come on-stream in energy-rich nations.

The same factors which caused a decrease in U.S. exports of chemicals also caused a decrease in U.S. imports since 1981. U.S. imports of all chemicals increased by an average of more than 9 percent per year during 1979-83, increasing from $5.5 billion to nearly $12.2 billion in 1983. U.S. imports of organic chemicals have been increasing at an even faster rate, more than 13 percent per year during 1979-83. The value of these imports increased from $1.5 billion in 1979 to more than $4.5 billion in 1983.

Figure 13 shows the U.S. organic chemical balance of trade with commodity petrochemical producing areas; and figure 14 shows the shares of world chemical production held by certain nations in 1983. Trade of specific items is discussed in the following section using data compiled from official statistics of the U.S. Department of Commerce.

Ethylene and its derivatives

Ethylene, because it is a gas at normal temperatures and pressure, is not a convenient material for international trade. Many of the large-volume commodity derivatives of ethylene, such as polyethylene resins, ethylene dichloride, and ethylene glycol, are either liquid or solid petrochemicals, and therefore much easier to transport. U.S. exports of major ethylene derivatives--polyethylene resins, ethylene oxide, ethylene dichloride, and ethylene glycol--during 1979-83 are reported in tables 16 through 19. 1/

The value of polyethylene resin exports exceeded imports by more than 13 fold in 1983, a level which was representative for the period 1980-83 (tables 16 and 20). However, in 1984, the value of U.S. exports of polyethylene declined to $583 million from $690 million in 1983; during 1980-84, the value of polyethylene exports declined overall by 27 percent. The leading markets for U.S. exports of polyethylene resins during 1980-84 generally have been China, Canada, and Mexico; together, they accounted for more than 34 percent of the polyethylene exports in 1984.

During 1980-81, Mexico was the major market for ethylene oxide exports; Venezuela was the leading market in 1982; and Canada was the leading market during 1984 (table 17). The value of exports of ethylene oxide declined sharply from more than $35 million in 1980 to about $5.0 million in 1983, thereafter increasing nearly 75 percent during 1983-84 to $8.3 million. The decline in exports during 1980-83 was attributed, by industry sources, to an ethylene oxide facility which began operations in Mexico.

1/ "Chemicals and Materials 1983 Review/1984 Forecast," Elastomerics, February 1984, pp. 13-19; "Chemical Exports: At Stake in the International Banking Rescue," Chemical Week, June 20, 1984, pp. 53-58; and, "Petrochemical Export Trend Called 'Disturbing' For the U.S.," Chemical Marketing Reporter, Apr. 16, 1984, pp. 3 and 15.

2/ Data for these items are based on official statistics of the U.S. Department of Commerce, as U.N. data are unavailable for these individual items.

FIGURE 13.--VALUE OF SALES OF PRODUCT LINES

BY COMPANY "B"

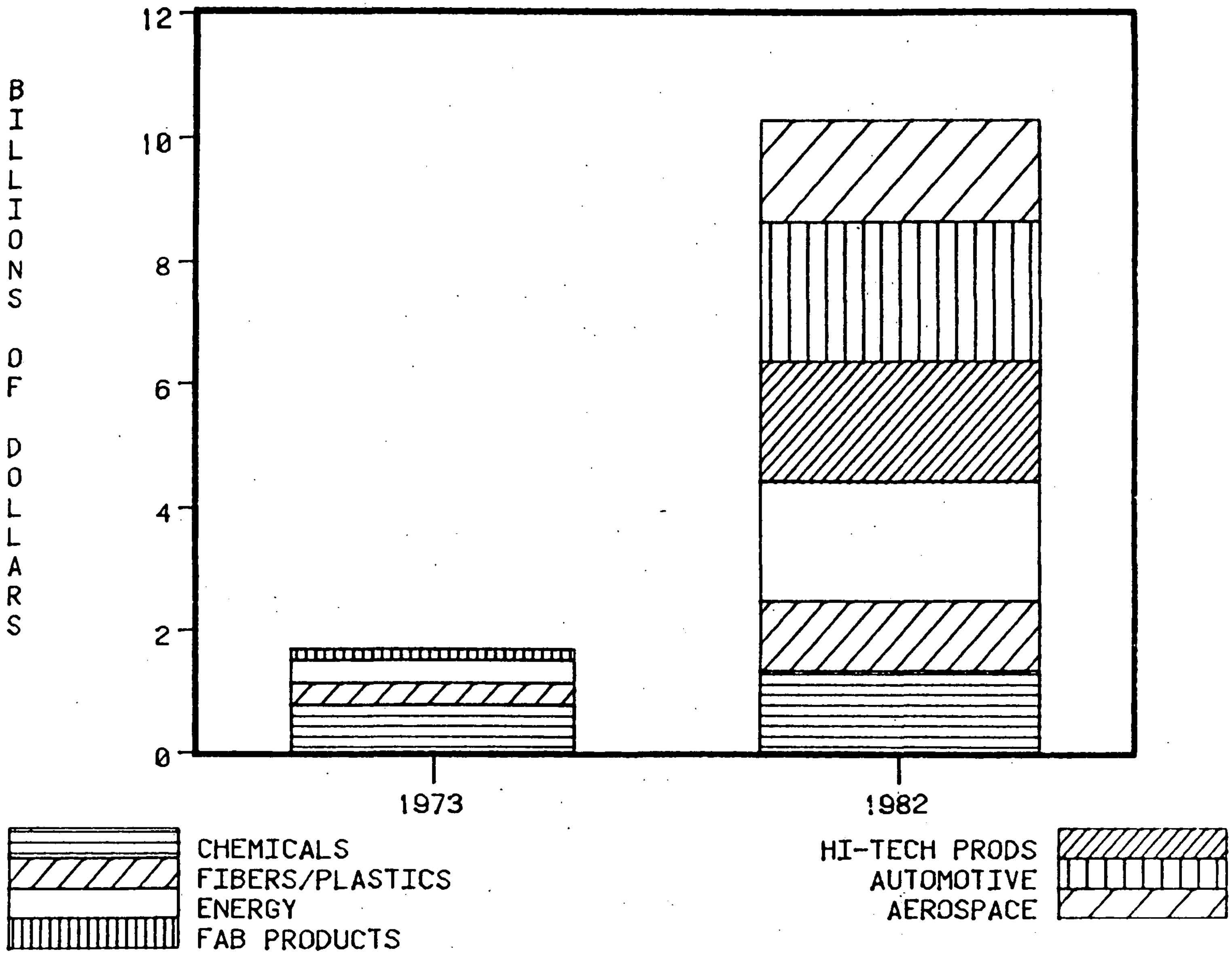
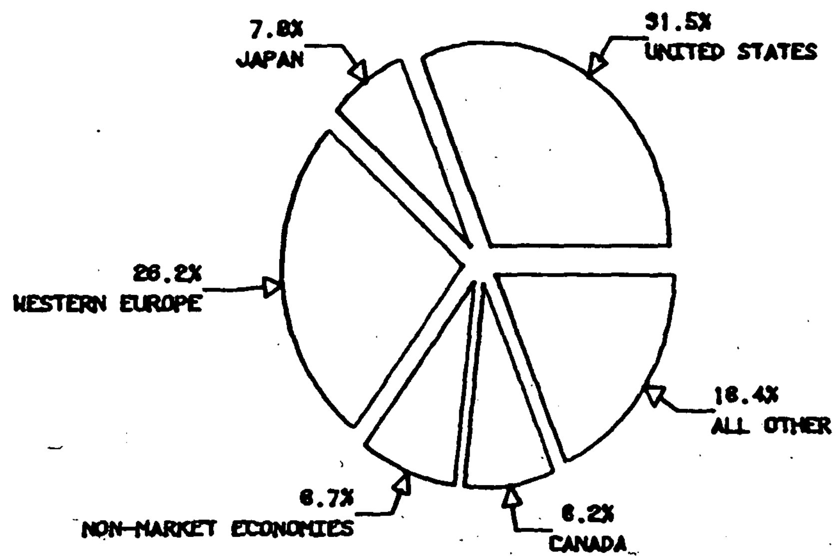


FIGURE 14.--CHEMICALS: CHEMICAL-PRODUCING NATIONS' SHARE OF WORLD

EXPORTS, 1983



NOTE: "ALL OTHER NATIONS"
INCLUDES CERN'S WITH NEW
PETROCHEMICAL CAPACITY

Table 16.--Polyethylene resins: U.S. exports of domestic merchandise, by principal markets, 1980-84

(In thousands of dollars)

Market	1980	1981	1982	1983	1984
China M-----	6,959	38,373	133,468	46,915	74,505
Canada------	46,924	55,206	58,175	78,735	69,685
Mexico------	135,443	140,663	101,367	103,500	57,039
Indnsia-----	34,425	28,459	43,962	40,863	32,329
Kor Rep-----	14,030	21,022	22,654	28,687	30,300
U King------	16,862	19,222	21,162	21,453	23,490
Hg Kong-----	31,729	19,885	22,816	21,267	19,428
Nethlds-----	19,159	15,066	16,746	11,701	18,468
Belgium-----	17,305	11,128	17,594	16,983	15,593
China t-----	15,867	8,940	12,127	23,849	14,090
All other---	464,075	287,641	290,121	296,075	228,184
Total---	802,778	645,605	740,191	690,028	583,112

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 17.--Ethylene oxide: U.S. exports of domestic merchandise, by principal markets, 1980-84

(In thousands of dollars)

Market	1980	1981	1982	1983	1984
Canada	1,069	204	429	3,201	2,925
Mexico	31,777	20,658	181	12	2,637
Venez	1,207	257	434	653	2,107
Argent	62	65	81	53	123
Kor Rep	-	1	3	415	121
Fr Germ	227	157	123	139	53
Spain	-	-	-	-	50
Panama	15	18	7	-	47
Rep Saf	21	36	24	39	34
Switzld	26	31	32	29	29
France	159	123	52	26	21
Chile	31	65	41	20	19
All other	667	695	3,615	169	136
Total	35,260	22,311	5,021	4,757	8,304

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 18.--Ethylene dichloride: U.S. exports of domestic merchandise, by principal markets, 1980-84

(In thousands of dollars)

Market	1980	1981	1982	1983	1984
Japan	23,677	23,207	41,579	66,682	52,258
China t	36,246	29,615	25,447	37,583	13,280
Mexico	2,849	562	4	5,190	11,012
Colomb	-	-	-	-	1,997
India	-	757	-	-	926
Peru	797	2,709	782	330	753
Venez	-	1	-	-	535
Singapr	68	126	68	140	65
Canada	189	91	5	4	18
Belgium	-	-	1	-	5
All other	11,559	409	2,222	687	11
Total	75,384	57,476	70,106	110,616	80,859

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 19.--Ethylene glycol: U.S. exports of domestic merchandise, by principal markets, 1980-84

(In thousands of dollars)

Market	1980	1981	1982	1983	1984
Japan	19,486	4,323	30,059	28,712	28,572
Belgium	329	2,623	3,333	6,845	24,496
Kor Rep	8,115	10,064	10,651	12,614	14,962
Rep Saf	3,331	4,652	5,824	9,611	12,371
Turkey	-	3,440	6,371	10,309	10,255
Italy	-	2	3	4,670	9,051
China t	979	4,647	6,965	15,448	7,649
Venez	2,501	3,350	2,374	2,549	5,689
Spain	-	-	-	-	5,598
Colomb	4,051	3,684	2,099	2,470	3,434
All other	21,074	15,121	22,177	23,685	16,643
Total	59,865	51,906	89,856	116,912	138,721

Source: Compiled from official statistics of the U.S. Department of Commerce.

The major markets for U.S. exports of ethylene dichloride during 1980-84 were Japan and Taiwan (table 18). In 1984, these two countries in the aggregate accounted for more than 84 percent of the value of ethylene dichloride exports, with Japan alone representing about 65 percent of the total value.

Exports of ethylene glycol increased from $60 million in 1980 to $139 million in 1984, or by 132 percent (table 19). This increase was virtually across the board to all of the major markets. Japan has been the single most important market in recent years, accounting for about 21 percent of the value in 1984. Belgium, the second largest market, accounted for approximately 18 percent of U.S. ethylene glycol exports.

The value of imports of polyethylene resins decreased during 1980-84 by more than 52 percent from $57 million in 1980 to $87 million in 1984 (table 20). This increase, in concert with a 46 percent increase in import quantity, reflects the strength of the U.S. dollar compared with other world currencies. 1/ The average unit value for imports of polyethylene resins declined from 45 cents per pound in 1980 to 32 cents per pound in 1983, or by almost 29 percent. In 1984, Canada was the leading source of U.S. imports of polyethylene resins, accounting for 59 percent of the value of these imports. Brazil was the second largest source of polyethylene in 1984, accounting for about 10 percent of the total value.

U.S. imports of ethylene oxide increased from $1.8 million to $3.2 million during 1980-84 (table 21). Imports of the principal product of ethylene oxide, ethylene glycol, also have increased.

The principal source for U.S. imports of ethylene dichloride during 1980-82 was Canada. West Germany became the principal source in 1983, and Brazil became the principal source in 1984. The value of the U.S. imports of ethylene dichloride increased from $1.3 million in 1980 to $9.3 million in 1981, and then declined to $2.8 million by 1984. The total effect during 1980-84 was an increase of 117 percent (table 22).

Imports of ethylene glycol increased from a value of $4.4 million in 1980 to $7.2 million in 1983, or by approximately 65 percent (table 23). During 1983-84, imports increased to nearly $22 million, or by almost 200 percent. Canada and Brazil were the leading source of imports of ethylene glycol during 1980-83; Canada, West Germany and Spain were the major sources in 1984, accounting in the aggregate for 70 percent of the value of U.S. imports of ethylene glycol. Canada remained the leading individual source of ethylene glycol in 1984, accounting for more than 27 percent of the value.

Methanol

The value of U.S. exports of methanol rose from $29 million in 1980 to more than $89 million in 1982, or by 288 percent (table 24). However, during 1982-84, the value of U.S. exports of methanol declined by more than 70 percent to approximately $27 million. Because increased production capacity

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1/ Council of Economic Advisers, Economic Report to the President, February 1984, p. 46.

Table 20.--Polyethylene resins: U.S. imports for consumption, by principal sources, 1980-84

(In thousands of dollars)

Source	1980	1981	1982	1983	1984
Canada	26,393	37,248	10,485	18,120	51,495
Brazil	1/	14	2	668	8,936
Chile	-	-	-	-	7,719
Argent	-	-	3,952	13,558	6,731
Venez	-	1	-	-	3,930
Fr Germ	23,710	7,170	4,627	4,809	2,993
Japan	4,060	1,578	1,042	2,380	2,356
U King	449	334	298	496	594
Belgium	148	511	53	168	462
Romania	-	-	-	-	304
All other	2,148	2,502	1,177	608	1,048
Total	56,908	49,358	21,635	40,807	86,567

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 21.--Ethylene oxide: U.S. imports for consumption, by principal sources, 1980-84

(In thousands of dollars)

Source	1980	1981	1982	1983	1984
Canada------	1,764	13,050	3,182	2,622	3,171
Fr Germ-----	3	6	1	17	22
U King------	1	-	376	15	12
Sweden------	-	-	-	40	-
Japan-------	1	-	1/	2	-
France------	1	-	-	-	-
Total---	1,769	13,056	3,559	2,695	3,205

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 22.--Ethylene dichloride: U.S. imports for consumption, by principal sources, 1980-84

(In thousands of dollars)

Source	1980	1981	1982	1983	1984
Brazil	-	439	151	1,039	2,032
Italy	-	-	-	-	762
Canada	1,285	8,875	5,960	-	3
Japan	-	-	-	-	2
Fr Germ	-	-	1/	2,914	-
Mexico	-	-	1,993	-	-
U King	2	-	-	-	-
Total	1,287	9,314	8,104	3,953	2,799

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 23.--Ethylene glycol: U.S. imports for consumption, by principal sources, 1980-84

(In thousands of dollars)

Source	1980	1981	1982	1983	1984
Canada	1,952	1,916	3,641	3,856	5,953
Fr Germ	132	154	360	284	5,034
Spain	-	-	-	-	4,114
Romania	-	-	-	431	3,699
U King	-	-	-	-	749
Brazil	1,879	2,354	192	1,061	669
Nethlds	-	-	-	-	635
Italy	-	-	-	89	342
Sweden	-	-	-	-	324
France	-	-	-	-	153
All other	435	634	765	1,525	-
Total	4,398	5,058	4,957	7,246	21,670

Source: Compiled from official statistics of the U.S. Department of Commerce.

coming on stream in Canada and Saudi Arabia is adding more low-priced material to the continuing oversupply in world methanol markets, U.S. exports are expected to continue to decline.

Meanwhile, U.S. imports of methanol, primarily from Canada, have been increasing from $16 million in 1980 to $57 million in 1984, or by 244 percent (table 25). Canada has remained the major source of these imports during 1980-84, accounting for about 90 percent of all methanol imports in 1983. Imports of methanol from Canada increased by by 476 percent during this period. Imports of methanol from a new plant in Trinidad entered the United States for the first time in 1984.

Ammonia

The value of U.S. exports of anhydrous ammonia remained fairly constant during 1980-82, decreasing from $107 million to $101 million (table 26). However, in 1983, as additional ammonia capacity came onstream in CERN's, U.S. ammonia exports fell to $48 million, or by 52 percent. A possible reason for this decline is that several export markets--Turkey, Spain, and Mexico 2/--no longer purchased as much U.S.-produced ammonia, and instead began relying on either their own new production of ammonia, or imports from other nations (e.g., Mexico and Trinidad) where new ammonia facilities have come onstream. During 1984, the value of U.S. exports increased to $89 million, with the major markets being Korea, the Philippines, and Taiwan.

As several of these new ammonia facilities based on lower-cost natural gas feedstock came onstream in Canada, Mexico, and Trinidad, ammonia imports became more price-competitive with domestic production. As a result, imports from these nations increased during 1980-84 (table 27). Also, imports from the Soviet Union increased during 1980-84. 3/ The value of U.S. ammonia imports steadily increased from $248 million in 1980 to nearly $474 million in 1984, or by approximately 91 percent.

1/ Other nations which purchased significantly less U.S.-produced ammonia in 1983 than during 1979-82 were the United Kingdom, West Germany, Trinidad, and France.

2/ Imports of ammonia from the Soviet Union were part of an agreement with one domestic company.

Table 24.--Methanol: U.S. exports of domestic merchandise, by principal markets, 1980-84

(In thousands of dollars)

Market	1980	1981	1982	1983	1984
U King	3	11	2	1,670	8,159
Nethlds	2,567	14,377	27,243	18,479	5,623
Japan	5,746	14,948	24,073	3,270	3,551
Rep Saf	1,266	2,090	8,566	1,795	2,486
Venez	1,650	666	1,477	1,234	943
Brazil	1,783	564	855	146	921
Colomb	550	355	448	393	889
Canada	74	39	33	214	869
Romania	-	-	-	-	611
Chile	2,612	423	701	780	431
All other	12,693	35,642	25,874	17,194	2,237
Total	28,944	69,115	89,272	45,176	26,720

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 25.--Methanol: U.S. imports for consumption, by principal sources, 1980-84

(In thousands of dollars)

Source	1980	1981	1982	1983	1984
Canada	8,851	5,624	16,915	33,711	50,979
Trinid	-	-	-	-	5,241
N Zeal	-	-	-	-	314
Japan	-	1/	23	7	59
Fr Germ	2	8	15	22	25
Belgium	-	-	-	-	1
U King	654	1,079	1/	-	1
India	-	-	-	1	1
Mexico	4,694	3,430	668	2,535	-
Italy	-	-	-	1/	-
All other	2,241	3,129	1,169	1/	-
Total	16,441	13,270	18,791	36,277	56,622

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 26.--Anhydrous ammonia: U.S. exports of domestic merchandise, by principal markets, 1980-84

(In thousands of dollars)

Market	1980	1981	1982	1983	1984
Kor Rep	-	2,917	17,555	31,465	49,688
Phil R	2,649	3,190	2,759	-	7,790
China t	-	-	5	4	5,242
Turkey	32,938	24,066	37,521	1,809	4,806
Canada	6,440	10,127	6,499	9,110	3,536
Jordan	-	-	-	1	3,505
Rep Saf	-	1	-	1	2,812
India	-	-	-	-	2,295
Spain	-	-	-	-	1,910
Belgium	10,208	13,548	7,983	1,911	1,499
Mexico	2,025	3,923	4,370	299	835
Tnzania	753	-	-	-	625
All other	52,110	32,969	23,834	3,737	1,267
Total	107,122	90,740	100,525	48,336	85,812

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 27.--Anhydrous ammonia: U.S. imports for consumption, by principal sources, 1980-84

(In thousands of dollars)

Source	1980	1981	1982	1983	1984
USSR	94,796	78,414	88,765	85,722	139,604
Canada	56,576	60,561	83,314	111,229	131,457
Trinid	38,650	44,535	39,370	66,050	125,883
Mexico	42,290	59,675	76,691	69,491	48,456
Brazil	-	-	-	-	10,958
Venez	94	-	2,315	3,164	7,939
F W Ind	-	752	1,520	7,797	5,712
Nethlds	1,351	-	-	-	1,919
Fr.Germ	-	-	-	-	1,068
Dom Rep	-	-	-	-	515
Chile	-	-	-	-	344
China t	-	-	1	4	4
All other	667	3,659	4,057	1,044	-
Total	234,423	247,596	296,032	344,502	473,860

Source: Compiled from official statistics of the U.S. Department of Commerce.

POSSIBLE IMPLICATIONS OF A SHIFT FROM U.S PRODUCTION OF COMMODITY PETROCHEMICALS TO VALUE-ADDED SPECIALTY CHEMICALS

It has been increasingly difficulty for industry analysts and observers to categorize the true nature of the much-publicized "shift" from production of commodity petrochemicals to higher value-added specialty chemicals. The outward appearance of the "shift," highlighted by the strong growth of specialty chemicals areas and the industry-wide problems of overcapacity and stagnant demand that have plagued the commodity petrochemical industry is clear and obvious. However, the overwhelming majority of those companies which have traditionally been the major producers and suppliers of commodity petrochemicals have not changed in any noticeable fashion. Additionally, the majority of the growth in specialty chemicals areas has been experienced by those companies which have been committed to the production of specialty chemicals throughout their existence and not those which have entered into this particular sector of the chemical industry in recent years. 1/

The drive toward a specialty chemical orientation by large commodity producers is viewed by many industry analysts as a natural progression for these firms 2/ and not a significant change in strategic goals for the industry in general. The changes in the U.S. commodity petrochemical industry during 1975-85, as well as in the commodity petrochemical industries of other traditional producers, have been interpreted by many industry observers as a search for profit-generating products, instead of as a primary shift in production philosophy. 3/ Regardless of the driving force behind the "shift," the higher rate of growth in specialty chemicals areas when compared with the expected slower growth in commodities, is expected to give the specialty chemicals sector an increasingly greater share of both the volume and value of U.S. chemical industry production in the coming decade.

The first part of this section examines several supply-demand scenarios for the commodity petrochemicals sector. Accompanying these commodity petrochemical supply-demand scenarios are corresponding scenarios for a generic "specialty chemical" product area. These two groups of scenarios, examined together, are used to generate an image of the possible implications which could result from anticipated changes in the U.S. and the world petrochemical industries, including changes in U.S. net trade. 4/

The second part of this section examines the possible quantitative impacts which could be expected to result from these scenarios in terms of

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1/ This is especially true of those specialty chemical firms which have been absorbed by larger petrochemical producers and have had increased amounts of steady and reliable funding available for R. & D. and new product development.

2/ Information collected in the context of conversations with various chemical industry consultants and securities analysts.

3/ Ibid.

4/ This exercise was performed previously on ethylene, methanol, and ammonia supply-demand scenarios, and the results were published in USITC Publication 1370, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy-Rich Nations, April 1983. The Bureau of Labor Statistics (BLS) Input-Output Model which was used in this previous exercise, as well as many of the independent variables, have been recently updated with information from the 1977 Census of Manufactures.

domestic output and domestic employment. The U.S. Department of Labor's input/output (I/O) model of the U.S. economy was used for this assessment. 1/

Future Supply-Demand Scenarios

In this section we are charged with setting up a realistic set of scenarios which can be later employed to generate possible economic changes in the U.S. industrial economy. In order to best examine all of the possibilities, the two sides of the chemical industry we have addressed throughout this report, commodity petrochemicals and specialty chemicals, will be treated in separate scenarios.

The information which has been used to generate these scenarios has been obtained from field visits, company submissions, consultant's reports, industry journals, other publications, and telephone conversations. The scenario bases which are discussed are logical and consistent with historical facts; however, the reader may construct any number of alternate scenarios by altering any of the assumptions or changing any of the independent variables. The scenarios as presented in this section are not, in any manner, to be construed as forecasts. 2/

Commodity Petrochemicals

Table 28 shows the principal assumptions used in each of the three scenarios for U.S. producers of commodity petrochemicals. For this analysis, we are looking at three sectors of the I/O model--Sector 46, which contains the production of most commodity petrochemicals; 3/ Sector 47, the agricultural chemical sector which includes ammonia and many of its derivative commodity petrochemicals; and Sector 49, containing commodity plastics resins

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1/ U.S. Department of Commerce, Bureau of Economic Analysis, Definitions and Conventions of the 1972 Input-Output Study, July 1980.

2/ Certain assumptions as to the general economic outlook need to be made in order to provide a context for the application of the I/O model to the scenarios. We are assuming a "business-as-usual" outlook for scenario I (baseline scenario), a continuation of the same conditions we see "today." The "hi-" and "lo-" growth scenarios tend to take into account any single event which would either positively or negatively influence the "business-as-usual" world situation. For a more detailed explanation of the use of scenarios, see USITC Publication 1370, The Probable Impact on the U.S. Petrochemical Industry of the Expanding Petrochemical Industries in the Conventional Energy-Rich Nations, April 1983, pp. 142-148.

3/ This sector does not contain anhydrous ammonia, but does include industrial inorganic chemicals.

Table 28.--Principal assumptions for the commodity petrochemical scenarios

Scenario I	Scenario II	Scenario III
(1) "Business-as-usual" (2) Net addition to world capacity during 1985-95 to satisfy increasing demand. (3) Increasing plant utilization rates during 1985-95. (4) Average annual rate of growth of domestic commodity petrochemical output rate of 1-2 percent higher than the growth of the Gross National Product (GNP). (5) Real U.S. and world demand growth rates of 4 percent-per-year during 1985-95. 1/	(1) Low-growth. (2) Domestic demand increases but decreasing export opportunities slow overall demand growth. (3) Higher plant utilization rates are not sustained as capacity increased as rapidly as demand during 1985-95. (4) Average annual rate of growth of domestic commodity petrochemical output approximately equal to that of GNP. (5) Real U.S. and world demand growth rates of 2 percent-per-year during 1985-95. 1/	(1) High-growth. (2) Demand in developing nations increases faster than expected, absorbing new commodity petrochemicals produced in CERN's with little or no effect on U.S. export markets. (3) Increasing demand and successful rationalization of out-dated, inefficient facilities allows for sustained higher plant utilization rates. (4) Average annual rate growth of commodity petrochemical output of approximately 4 percent greater than the rate of growth of the GNP. (5) Real U.S. and world demand growth rates of 6 percent-per-year during 1985-95. 1/

1/ Real and U.S. demand growth rate for all scenarios is -1.5 percent during 1980-85.

and synthetic rubber. 1/ These three sectors are defined by the Standard Industrial (SIC) System categories shown in the following tabulation:

Sectors	SIC codes
Sector 46.--Industrial inorganic and organic chemicals	Group No. 281.-- Industrial inorganic chemicals 1/ Group No.286.--Industrial organic chemicals 2/
Sector 47.--Agricultural chemicals	Group. No. 287.--Agricultural chemicals.
Sector 49.--Plastic(s) materials and synthetic rubber	Industry No. 2821.--Plastics materials, sythetic resins, non-vulcanizable elastomers. Industry No. 2822.--Synthetic rubber (vulcanizable elastomers).

1/ Not including SIC No. 28195, aluminum oxide.
2/ Not including SIC No. 2861, gum and wood chemicals.

Historical data for these three sectors are shown in tables 29 through 31. As can be seen from examining the growth patterns of these three sectors of the U.S. economy, a similar pattern emerges for all of them. During 1958-73, all of these sectors experienced better than average growth in their output, as output increased at average annual rates between 2.9 percent and 8.3 percent greater than the GNP. During 1973-79, the average annual growth rate slowed. However, rates of inflation in these sectors ranging from 12.6 percent to 13.8 percent created large increases in revenue from commodity petrochemical sales, and fueled a false sense of limitless growth possibilities and unbounded demand. As the effects of the two crude petroleum price shocks began being felt, the growth in output in constant dollars reversed. During 1979-83, the output in the agricultural chemical sector declined at an average annual rate of approximately 4.3 percent. During the same period, the industrial chemical sector's output fell at an average annual rate of 4.4 percent. The growth in the plastics sector managed to remain in a positive direction, although slowing to an average annual rate of 1.1 percent. A partial summation of demand in these sectors for 1980, as indicated by the output data in tables 29-31 appears in table 32, along with an estimate of demand for 1985, 1990, and 1995 under the base scenario.

Table 29.—Sector 46; Industrial inorganic and organic chemicals: Time-series data for input-output industries, output and employment, 1958-83

Year	Output (millions of dollars) Current dollars	Output (millions of dollars) Constant dollars	Output deflator (1972=100)	Employment (thousands of jobs) Total	Employment (thousands of jobs) Wage and salary
1958	7,063	7,007	100.8	260	259
1959	8,171	8,082	101.1	260	259
1960	8,359	8,155	102.5	267	266
1961	8,550	8,407	101.7	264	263
1962	9,193	9,175	100.2	264	263
1963	9,853	9,932	99.2	265	264
1964	10,692	10,833	98.7	270	269
1965	11,661	11,673	99.9	269	268
1966	12,497	12,410	100.7	281	281
1967	12,557	12,311	102.0	291	290
1968	13,280	13,097	101.4	292	290
1969	14,108	14,323	98.5	296	295
1970	14,361	14,433	99.5	297	296
1971	14,675	14,617	100.4	287	285
1972	16,098	16,098	100.0	278	278
1973	18,568	17,759	104.6	284	283
1974	27,290	17,640	154.7	292	292
1975	30,187	14,584	207.0	292	292
1976	36,370	17,074	213.0	304	304
1977	42,059	19,213	218.9	321	321
1978	44,921	19,674	228.3	326	326
1979	52,135	19,646	265.4	328	327
1980	58,016	18,214	318.5	330	329
1981 1/	63,627	18,227	349.1	334	333
1982 1/	52,003	15,330	339.2	327	325
1983 1/	56,311	17,087	329.6	312	311
	Average annual rates of change				
1958-83	9.7	3.8	5.7	1.0	1.0
1958-65	6.7	7.0	-0.4	0.5	0.5
1965-73	5.1	5.0	0.2	0.3	0.3
1973-79	17.1	2.9	13.8	2.7	2.7
1979-83	0.4	-4.4	5.1	-1.1	-1.1

1/ Preliminary.

Source: Bureau of Labor Statistics, U.S. Department of Labor.

Table 30.--Sector 47; Agricultural chemicals: Time-series data for input-output industries, output and employment, 1958-83

Year	Output (millions of dollars)		Output deflator (1972=100)	Employment (thousands of jobs)	
	Current dollars	Constant dollars		Total	Wage and salary
1958	1,569	1,633	96.1	53	52
1959	1,782	1,862	95.7	54	53
1960	1,853	1,908	97.1	54	53
1961	1,878	1,932	97.2	55	54
1962	2,019	2,070	97.5	57	56
1963	2,853	2,347	96.0	60	59
1964	2,468	2,654	93.0	60	59
1965	2,697	2,874	95.5	69	68
1966	3,027	3,064	98.8	64	63
1967	3,171	3,200	99.1	67	66
1968	3,161	3,242	97.5	67	66
1969	3,243	3,576	90.7	65	64
1970	2,968	3,104	95.6	64	63
1971	3,101	3,058	101.4	58	58
1972	3,547	3,547	100.0	56	56
1973	4,267	3,996	106.8	60	59
1974	6,848	4,943	138.5	64	63
1975	8,412	4,348	193.4	65	65
1976	8,342	4,455	187.3	68	67
1977	9,237	4,718	195.8	68	68
1978	9,931	4,626	214.7	67	67
1979	11,868	4,903	242.1	70	70
1980	14,321	5,007	286.0	72	72
1981 1/	16,023	5,123	312.8	70	70
1982 1/	14,225	4,429	321.2	65	65
1983 1/	12,900	4,187	308.1	61	61
	Average annual rates of change				
1958-83	10.1	4.4	5.5	0.9	0.9
1958-65	7.5	7.8	-0.3	2.4	2.4
1965-73	3.7	2.9	0.9	-1.4	-1.3
1973-79	15.1	2.0	12.7	2.2	2.5
1979-83	1.6	-4.3	6.2	-3.7	-3.7

1/ Preliminary.

Source: Bureau of Labor Statistics, U.S. Department of Labor.

Table 31.--Sector 49; Plastic materials and synthethic rubber: Time-series data for input-output industries, output and employment, 1958-83

Year	Output (millions of dollars) Current dollars	Output (millions of dollars) Constant dollars	Output deflator (1972=100)	Employment (thousands of jobs) Total	Employment (thousands of jobs) Wage and salary
1958	2,361	1,890	124.9	77	77
1959	2,994	2,470	119.2	81	81
1960	2,908	2,456	118.4	84	84
1961	2,797	2,475	113.0	83	83
1962	3,111	2,780	111.9	89	89
1963	3,306	2,968	111.4	93	93
1964	3,555	3,294	107.9	94	94
1965	3,938	3,636	108.3	97	97
1966	4,479	4,182	107.1	102	102
1967	4,368	4,105	106.4	103	103
1968	4,690	4,644	101.0	106	106
1969	5,239	5,218	100.4	108	108
1970	5,096	5,046	101.0	106	106
1971	5,389	5,389	100.0	103	103
1972	5,529	5,529	100.0	105	105
1973	6,189	5,973	103.6	109	109
1974	9,383	6,041	155.3	111	111
1975	8,448	4,487	188.3	98	97
1976	10,874	5,479	198.5	99	98
1977	12,588	6,128	205.4	98	98
1978	13,801	6,528	211.4	99	99
1979	16,798	6,759	248.5	100	100
1980	17,417	5,905	295.0	95	95
1981 1/	19,635	6,322	310.6	93	93
1982 1/	17,966	5,906	304.2	89	89
1983 1/	22,226	7,133	311.6	87	87
	Average annual rates of change				
1958-83	9.4	4.7	4.5	0.5	0.5
1958-65	6.2	8.3	-2.0	3.3	3.3
1965-73	5.0	5.9	-0.8	0.9	0.9
1973-79	16.0	3.0	12.6	-1.7	-1.7
1979-83	6.1	1.1	6.0	-3.4	-3.4

1/ Preliminary.

Source: Bureau of Labor Statistics, U.S. Department of Labor.

Historical trade patterns for commodity petrochemical sectors, as defined by the I/O model, are shown in tables 33-35. The historical rates of growth in trade within these individual sectors (whether positive or negative) are used along with the I/O Model scenarios (table 28) to arrive at a picture of a base trade scenario projection for these commodity petrochemical sectors for 1985 and 1990 (table 36). The degree of uncertainty concerning conditions and developments in many areas of the world which are less economically and politically stable than the United States makes trade projections beyond 1990 fairly meaningless.

As can be seen from the information in table 36, the United States may become a net importer of commodity petrochemicals by 1990, as imports capture an increasing share of the U.S. market. The following tabulation shows some base scenario projections of U.S. industry statistics for the commodity petrochemicals sector for 1990 (in millions of constant 1980 dollars):

	1980	1990
Demand	89,754	103,100
Exports	16,345	16,300
Imports	8,095	17,000
Production 1/	98,004	102,400
Ratio of imports to consumption (percent)	9.0	16.5
Ratio of exports to production (percent)	16.7	16.9

1/ Demand plus exports minus imports.

Table 32.--Commodity petrochemicals: Actual demand, 1980, and projected demand under Scenarios I, II, and III; 1985, 1990, and 1995

(In millions of constant 1980 dollars)

Year	Sector 46 Industrial chemicals	Sector 47 Agricultural chemicals	Sector 49 Plastics and synthetic rubber 1/	Total
1980	58,016	14,321	17,417	89,754
1985:				
Scenario I	49,500	12,200	22,000	83,700
Scenario II	49,500	12,200	22,000	83,700
Scenario III	49,500	12,200	22,000	83,700
1990:				
Scenario I	60,000	14,500	28,600	103,100
Scenario II	55,000	13,500	25,300	93,800
Scenario III	67,000	15,900	33,000	115,900
1995:				
Scenario I	73,000	17,500	36,500	127,000
Scenario II	60,500	14,900	29,000	104,400
Scenario III	90,000	21,000	42,000	153,000

1/ Faster demand growth is anticipated for the plastics resins since many specialty grades of plastics resins are included in this sector.

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

Table 33.--Industrial chemicals: U.S. imports, exports, and balance of trade, 1979-83

(in thousands of dollars)

Flow of Trade / Partner (Year)	1979	1980	1981	1982	1983
Imports					
WESTERN EUROPE	2,192,459	2,446,949	2,359,610	2,547,173	3,118,250
JAPAN	372,192	424,022	566,208	536,736	661,273
CANADA	1,404,311	1,462,192	1,722,467	1,736,453	1,480,610
MEXICO	150,701	158,808	199,202	208,521	219,753
MIDDLE EAST	12,505	15,681	40,268	21,431	23,674
NON-MARKET ECONOMIES	132,251	263,317	193,897	203,132	179,046
WORLD	5,147,980	6,017,931	6,450,481	6,678,488	7,387,478
Exports					
WESTERN EUROPE	2,716,946	2,895,468	2,877,467	2,770,723	2,433,399
JAPAN	833,059	982,074	1,212,792	1,289,419	1,279,906
CANADA	852,270	935,854	1,064,020	864,396	1,009,375
MEXICO	635,084	807,558	871,080	609,349	603,354
MIDDLE EAST	97,935	104,629	117,401	106,212	89,764
NON-MARKET ECONOMIES	160,857	110,048	263,348	341,857	289,464
WORLD	7,624,020	8,656,395	9,162,755	8,526,195	8,278,219
Trade Balance					
WESTERN EUROPE	524,487	448,519	517,857	223,550	-684,850
JAPAN	460,868	558,053	646,585	752,683	618,633
CANADA	-552,040	-526,337	-658,446	-872,056	-471,234
MEXICO	484,382	648,751	671,878	400,828	383,601
MIDDLE EAST	85,431	88,948	77,133	84,781	66,090
NON-MARKET ECONOMIES	28,605	-153,269	69,451	138,725	110,418
WORLD	2,476,040	2,638,464	2,712,273	1,847,707	890,741

Source: Compiled from official statistics of the U.N. Trade Data System.

Table 34.--Agricultural chemicals: U.S. imports, exports, and balance of trade, 1979-83

(in thousands of dollars)

Flow of Trade Partner / Year	1979	1980	1981	1982	1983
Imports					
WESTERN EUROPE	243,514	338,733	316,553	336,679	297,943
JAPAN	31,095	36,945	52,870	31,130	30,092
CANADA	856,563	955,372	1,040,832	795,087	772,991
MEXICO	4,502	5,928	3,924	1,580	10,963
MIDDLE EAST	29,003	39,480	65,435	74,789	68,674
NON-MARKET ECONOMIES	4,872	15,648	9,506	28,004	82,449
WORLD	1,184,618	1,409,379	1,506,318	1,290,074	1,321,194
Exports					
WESTERN EUROPE	730,946	895,355	745,078	651,255	628,290
JAPAN	115,333	154,582	153,408	182,229	199,539
CANADA	221,076	234,607	256,203	249,288	284,216
MEXICO	60,414	105,087	129,297	108,075	74,008
MIDDLE EAST	12,214	13,487	14,683	26,239	13,314
NON-MARKET ECONOMIES	79,669	192,680	205,276	211,499	239,100
WORLD	2,377,016	3,341,930	2,817,850	2,508,814	2,411,999
Trade Balance					
WESTERN EUROPE	487,432	556,622	428,524	314,576	330,346
JAPAN	84,238	117,636	100,538	151,099	169,448
CANADA	-635,486	-720,764	-784,628	-545,798	-488,773
MEXICO	55,913	99,160	125,373	106,495	63,044
MIDDLE EAST	-16,788	-25,991	-50,751	-48,549	-55,359
NON-MARKET ECONOMIES	74,797	177,033	195,771	183,495	156,651
WORLD	1,192,398	1,932,551	1,311,531	1,218,740	1,090,805

Source: Compiled from official statistics of the U.N. Trade Data System.

Table 35.--Plastics resins: U.S. imports, exports, and balance of trade, 1979-83

(in thousands of dollars)

Year / Flow of Trade Partner	1979	1980	1981	1982	1983
Imports					
WESTERN EUROPE	332,431	334,357	327,408	317,381	442,512
JAPAN	130,831	145,495	210,144	194,222	266,940
CANADA	90,717	103,828	143,639	127,837	188,151
MEXICO	4,489	4,894	7,372	11,189	32,472
MIDDLE EAST	5,224	3,847	8,013	6,353	14,191
NON-MARKET ECONOMIES	807	263	264	518	4,212
WORLD	625,823	668,460	793,058	777,556	1,147,955
Exports					
WESTERN EUROPE	787,442	988,570	909,561	888,355	944,439
JAPAN	221,451	247,285	291,372	309,559	345,345
CANADA	500,990	514,850	619,897	535,396	664,351
MEXICO	211,979	315,853	367,311	275,418	273,164
MIDDLE EAST	67,293	98,988	97,992	103,629	87,944
NON-MARKET ECONOMIES	53,757	128,196	174,939	240,009	95,443
WORLD	3,192,268	3,871,225	3,813,798	3,657,152	3,737,557
Trade Balance					
WESTERN EUROPE	455,011	654,213	582,153	570,974	501,927
JAPAN	90,619	101,790	81,228	115,338	78,405
CANADA	410,272	411,022	476,258	407,559	476,200
MEXICO	207,489	310,958	359,939	264,228	240,692
MIDDLE EAST	62,069	95,140	89,978	97,276	73,753
NON-MARKET ECONOMIES	52,950	127,933	174,675	239,492	91,232
WORLD	2,566,445	3,202,765	3,020,740	2,879,596	2,589,602

Source: Compiled from official statistics of the U.N. Trade Data System.

Table 36.--Commodity petrochemicals: U.S. imports, exports, and balance of trade actual data, 1980; and projected data, 1985 and 1990

(In millions of constant 1980 dollars)

	1980 1/	1985	1990
Industrial chemicals: 2/			
Imports	6,018	8,700	11,750
Exports	8,656	9,000	9,900
Trade balance	2,638	300	-1,850
Agricultural chemicals: 3/			
Imports	1,409	1,350	2,250
Exports	2,818	2,300	2,950
Trade balance	1,409	950	-290
Plastics resins:			
Imports	668	1,500	3,000
Exports	3,871	3,850	4,350
Trade balance	3,203	2,350	-1,350
Total:			
Imports	8,095	11,550	17,000
Exports	16,345	15,150	16,300
Trade balance	7,250	3,600	-700

1/ Compiled from official statistics of the U.N. Trade Data System.
2/ Closely approximates Sector 46 of I/O Model.
3/ Closely approximates Sector 47 of I/O Model.
4/ Closely approximates Sector 49 of I/O Model, although synthetic rubber is not included.

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications, except as noted.

The following tabulation shows the result of the Scenario II and Scenario III assumptions applied to historical trade data in order to generate low-demand case and high-demand case projections for U.S. commodity petrochemical net trade balance in 1990 (in millions of constant 1980 dollars).

	Scenario II	Scenario III
Domestic demand----------	93,800	115,900
Exports------------------	15,000	17,500
Imports------------------	17,000	15,000
Production---------------	91,800	118,400
Net trade balance--------	-2,000	2,500

Many analysts would view the possibility of increased import penetration into the U.S. market by commodity petrochemical producers located in CERN's as the most significant of the trends indicated by the data in the previous tabulation, as U.S. and world industrial consumers of commodity petrochemicals continue their efforts to remain competitive by minimizing their own raw material feedstock costs.

Specialty Chemicals

The principal assumptions of the specialty chemicals scenarios are far simpler than those of the commodity petrochemicals scenarios. Only the anticipated growth rates are actually affected by demand variations in these scenarios, as issues such as capacity utilization and capacity additions far in excess of demand requirements are moot for industry operations such as those of the specialty chemicals sector. The base scenario shows a real annual demand growth rate for the U.S. specialty chemicals sector of 5 percent through 1990, and 4 percent during 1990-95. Scenario II, the "low-growth" scenario, projects a 3 percent annual demand growth rate from 1985 through 1995. Scenario III, the "high-growth" scenario, predicts a 5 percent per year demand growth rate through 1987, and a 7 percent annual growth rate during 1987-95.

Whether these rates projected in the scenarios come to pass depends on external factors such as the strength of U.S. currency, the price of the commodity petrochemical intermediates, 1/ and the overall world economic situation.

Table 37 contains historical industry statistics for the I/O model Sector No. 48, Chemical products, n.e.c., which contains the majority of the specialty chemicals we have considered in this study. This sector contains those industries comprising SIC Industry No. 2861, Gum and Wood Chemicals, and SIC Group No. 289, Miscellaneous Chemical Products.

Annual rates of growth for this sector have paralleled the rates for most chemical industry sectors; however, since 1979, output growth in current dollars for this sector neared an average annual rate of 7 percent. Also, the

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1/ The commodity petrochemical intermediates prices depend, in turn, on the prices of crude petroleum and natural gas-based feedstock materials.

Table 37.--Sector 48; Chemical products, n.e.c.: Time-series data for input-output industries, output and employment, 1958-83

Year	Output: Current dollars	Output: Constant dollars	Output deflator (1972=100)	Employment: Total	Employment: Wage and salary
	Million dollars			1,000 jobs	
1958	1,649	2,386	69.1	80	79
1959	1,817	2,720	66.8	82	81
1960	1,815	2,597	69.9	82	81
1961	1,842	2,613	70.5	82	81
1962	1,950	2,821	69.1	84	83
1963	2,102	2,788	75.4	83	82
1964	2,284	3,041	75.1	80	79
1965	2,483	3,246	76.5	83	82
1966	2,902	3,552	81.7	96	95
1967	3,114	3,835	81.2	113	112
1968	3,483	4,295	81.1	120	119
1969	3,710	4,370	84.9	124	123
1970	3,574	4,062	88.0	112	111
1971	3,895	4,243	91.8	98	98
1972	4,386	4,386	100.0	96	96
1973	4,969	4,460	111.4	98	97
1974	6,259	4,062	154.1	98	98
1975	6,163	3,762	163.8	89	89
1976	6,902	4,408	156.6	90	89
1977	7,961	4,722	168.6	95	94
1978	9,002	5,355	168.1	96	96
1979	10,320	5,933	173.9	99	99
1980	10,796	5,102	211.6	100	99
1981 1/	12,557	5,420	231.7	102	101
1982 1/	12,751	5,228	243.9	98	98
1983 1/	13,231	5,453	242.6	97	97
	Average annual rates of change				
1958-83	9.4	3.4	5.8	0.7	0.8
1958-65	5.5	3.6	1.8	0.2	0.2
1965-73	7.8	3.5	4.1	0.5	0.6
1973-79	12.0	6.0	5.6	0.2	0.3
1979-83	6.9	-1.4	8.4	-0.6	-0.5

1/ Preliminary.

Source: Bureau of Labor Statistics, U.S. Department of Labor.

rate of increase of the output deflator for this sector has remained somewhat steady, as opposed to the "flare-up" seen in commodity sectors during 1973-79.

The following tabulation shows the actual demand for the specialty chemicals in this sector for 1980, and the three scenarios of projected demand for 1985, 1990, and 1995 (in millions of constant 1980 dollars): 1/

	Sector 48 (Specialty Chemicals) demand)
1980	10,796
1985:	
Scenario I	13,750
Scenario II	13,750
Scenario III	13,750
1990:	
Scenario I	17,500
Scenario II	16,000
Scenario III	18,250
1995:	
Scenario I	22,350
Scenario II	18,500
Scenario III	26,000

The pattern of international trade in specialty chemicals is most closely approximated by the chemical products sector of the BLS I/O Model. Table 38 shows U.S. imports, exports, and balance of trade in specialty chemicals during 1979-83. Although in 1983 the value of U.S. exports of the items in this sector were seven times the value of imports, during 1979-83 the value of imports was increasing at almost twice the rate of export growth. The major trading partners which accounted for much of the increased imports were nations or areas from which these imports are thought to have almost peaked, thereby moderating the rate of increase of these imports during 1985-90. The rate of export growth is also expected to increase for this sector as both the economic recovery seen in the United States during 1983-84 spreads to developing nations, and these nations begin to become consumers of more sophisticated, higher value-added materials.

Table 39 shows a base-scenario trade projection for the specialty chemicals sector for 1985 and 1990. The information in this table shows the U.S. trade surplus in specialty chemicals increasing from $1.7 billion in 1980 to nearly $2.7 billion (constant 1980 dollars) in 1990. Placed in the context of the base-scenario demand projection for this sector, the following projection of industry statistics for 1990 emerges (in millions of constant 1980 dollars).

1/ Compiled by the staff the U.S. International Trade Commission with information obtained from industry, consultants, and publications.

Table 38.--Chemical products: U.S. imports, exports, and balance of trade, 1979-83

(in thousands of dollars)

Year / Flow of Trade / Partner	1979	1980	1981	1982	1983
Imports					
WESTERN EUROPE	114,483	134,411	133,677	146,541	127,742
JAPAN	20,661	20,883	29,903	28,730	41,175
CANADA	43,921	49,473	44,971	42,071	39,172
MEXICO	2,321	1,467	1,698	2,766	2,052
MIDDLE EAST	161	27	573	436	10,527
NON-MARKET ECONOMIES	131	191	2,547	3,161	452
WORLD	199,691	233,997	267,613	278,078	250,623
Exports					
WESTERN EUROPE	385,824	522,671	486,922	495,006	494,315
JAPAN	132,517	169,088	171,178	160,831	155,016
CANADA	179,749	210,538	261,223	229,896	240,735
MEXICO	76,604	108,628	131,379	83,883	67,937
MIDDLE EAST	57,472	102,626	117,411	128,342	77,017
NON-MARKET ECONOMIES	17,189	21,617	27,042	46,796	20,280
WORLD	1,526,610	1,937,218	2,012,479	1,878,136	1,764,124
Trade Balance					
WESTERN EUROPE	271,341	388,260	353,245	348,465	366,573
JAPAN	111,855	148,205	141,275	132,101	113,841
CANADA	135,828	161,065	216,252	187,824	201,563
MEXICO	74,283	107,160	129,681	81,117	65,885
MIDDLE EAST	57,310	102,599	116,837	127,906	66,490
NON-MARKET ECONOMIES	17,059	21,426	24,495	43,635	19,828
WORLD	1,326,919	1,703,221	1,744,866	1,600,058	1,513,502

Source: Compiled from official statistics of the U.N. Trade Data System.

Table 39.--Specialty chemicals: 1/ U.S. imports, exports, and balance of trade, actual data 1980; and projected data, 1985 and 1990.

(In millions of constant 1980 dollars)

	1980 2/	1985	1990
Imports	234	300	400
Exports	1,937	2,200	2,675
Trade balance	1,703	1,900	2,275

1/ Closely appromates Sector 48 of I/O Model.
2/ Compiled for official statistics of the U.N. Trade Data System.

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications, except as noted.

	1980	1990
Demand	10,796	16,000
Exports	1,937	2,675
Imports	234	400
Production 1/	12,499	18,275
Ratio of imports/consumption (percent)	2.2	2.5
Ratio of exports/production (percent)	15.5	14.6

1/ Demand plus exports minus imports.

Variations in trade for the specialty chemicals sector between the low-demand case and high-demand case scenarios would be minimal, as most, if not all, variations in production would be absorbed by U.S. demand.

The most common observation concerning the trade projection for this sector would most likely be the anticipation of real growth. Although the ratio of imports to consumption is projected to increase slightly, the growth in world trade in specialty chemicals among the industrialized nations, generally the traditional petrochemical producers, is expected to account for much of this increase. Also, trade in specialty chemicals with the United States' traditional trading partners, Canada and Mexico, is expected to account for a significant share of U.S. specialty chemical trade, as these nations further develop their burgeoning commodity petrochemical industries and progress into fields in which needs for value-added specialty chemicals may be most easily met by U.S.-produced materials.

Integrated Scenarios

Table 40 shows the resulting projection for petrochemical trade for 1985 and 1990, which is derived by combining the commodity base trade scenario and the specialty chemical base trade scenario. Although the positive balance of trade expected in the specialty chemicals sector would somewhat moderate the declining trade balance for commodity petrochemical sectors, it is not anticipated to approach the size necessary to reverse this trend. The overall trade balance in this base scenario declines by an average annual rate of 7.5 percent during 1980-85; the rate of decline increases to an average annual rate of 12 percent during 1985-90.

Table 40.--Petrochemicals sectors: U.S. imports, exports, and balance of trade, actual data 1980; and base case projected data, 1985 and 1990.

	1980	1985	1990
Commodity petrochemicals:			
Imports	8,095	11,550	17,000
Exports	16,345	15,150	16,300
Trade balance	7,250	3,600	-700
Specialty chemicals:			
Imports	234	300	400
Exports	1,937	2,200	2,675
Trade balance	1,703	1,900	2,275
Total petrochemical sectors:			
Imports	8,329	11,850	17,400
Exports	18,282	17,350	18,975
Trade balance	9,953	5,500	1,575

Source: Compiled by the staff of the U.S. International Trade Commission with information obtained from industry, consultants, and publications, except as noted.

The following tabulation shows the low-demand case and high-demand case integrated net trade scenarios for 1990 (in millions of constant 1980 dollars).

	Scenario II	Scenario III
Commodity petrochemicals:		
Imports	17,000	15,000
Exports	15,000	17,500
Trade balance	-2,000	2,500
Specialty chemicals:		
Imports	400	400
Exports	2,675	2,675
Trade balance	2,275	2,275
Total petrochemical sector:		
Imports	17,400	15,400
Export	17,675	20,175
Trade balance	275	4,775

Quantitative Impacts of Hypothetical Changes on the U.S. Industrial Economy

Input/Output Model

The U.S. Department of Labor I/O Model was used to calculate the change in U.S. industry output and employment which would result from certain hypothetical changes in final demand for several sectors of the U.S. industrial economy. The model used in this study is based on a Bureau of Labor Statistics estimate of the 1977 input/output relationships in the U.S. economy, along with the 1982 employment/output relationships and the 1977 total requirements output relationships. 1/ It should be noted that, as in any future-oriented research based on historical relationships, the future relationships may differ significantly from those in the past. Although the demand scenarios presented in the previous section dealt with 1990 and 1995, we are still applying to them a 1977/82 model (with the most up-to-date available information incorporated), and the resulting changes must be understood to be only hypothetical.

Changes in Industry Output

The following matrix tabulation shows changes in industrial output for the U.S. economy and certain key sectors as indicated by the I/O model. The values listed are the expected changes associated with a $1.0 million change in demand for the commodity petrochemical and specialty chemical sectors (in millions of dollar): 2/

	Industrial chemicals	Agricultural chemicals	Plastics resins and synthetic rubber	Specialty chemicals
Chemicals and allied products:				
Commodity sectors	1.87	1.04	0.84	0.05
Specialty sector	.60	.02	.06	.88
All other	.29	.03	.13	.06
Total	2.76	1.09	1.03	.99
Total U.S. economy	6.56	2.01	2.28	1.43

The reason for the apparent lesser impact of increased demand in the specialty chemicals sector lies in its innate higher value-added nature. These products are at such an advanced stage of manufacture, that a demand change does not in turn find itself echoed through the manufacture of several other products, each having a higher value-added state than the previous one.

1/ Total requirements are the summed inputs from all sectors of the economy which are together required to produce a generic product from any one particular sector.

2/ Based on U.S. Department of Labor's I/O Model.

Therefore, the demand change in the specialty chemicals sector is not amplified as is a demand change in commodity petrochemicals sectors.

Table 41 shows the expected output changes, both for the overall economy and several key sectors, predicted by applying the I/O Model to the demand scenarios for 1985, 1990, and 1995.

Changes in Industry Employment

The following matrix tabulation shows changes in U.S. employment for the U.S. economy and certain key sectors. The numbers of jobs listed in this matrix are those associated with a $1 million change in demand in the sectors shown by the I/O Model (in number of jobs):

	Industrial chemicals	Agricultural chemicals	Plastics resins and synthetic rubber	Specialty chemicals
Chemicals and allied products:				
Commodity sectors	12.52	5.22	4.29	0.45
Specialty sector	1.42	.09	.33	7.52
All other	4.60	.18	.67	.56
Total	18.54	5.49	5.29	8.53
Total U.S. economy	42.01	9.88	11.59	14.87

Table 42 summarizes the projected employment changes which are related to individual sectors and scenarios. 1/

Quantitative Impact of "Shift"

Using the 1980 demand, output, and employment data as a base, the hypothetical changes summarized in tables 41 and 42 would alter the shares of the U.S. chemical and allied products industry for 1985, 1990, and 1995, as shown in figures 15-18. As of 1990, the output of the chemicals and allied products industry is projected by the I/O Model to increase as a result of the changes anticipated in the commodity petrochemicals sectors and the specialty chemicals sector by between $4.1 billion and $49.9 billion. Employment in the chemicals and allied products industry is projected to increase by between 25,000 and 322,000 jobs during the same period. The anticipated effects on the overall U.S. economy during the 1980-90 period, based on the I/O model, would be an increased output of between $4.0 billion and $301 billion. The total employment for the entire U.S. economy, as projected by the I/O Model, is an increase of between 4,000 and 685,000 jobs.

1/ Ibid.

Table 41.— U.S. economic output changes derived from I/O model and demand scenarios, 1985, 1990, and 1995 1/

(In millions of 1980 dollars)

	Change in output related to:					
	Industrial chemicals sector	Agricultural chemicals sector	Plastics resins and synthetic rubber sector	Total commodity petrochemical sectors	Specialty chemicals sector	Total effect of "shift"
Chemicals and allied products:						
Scenario I:						
1980-85	-23,504	-2,312	4,720	-21,096	2,924	-18,172
1980-90	5,476	195	11,518	17,189	6,637	23,826
1980-95	41,356	3,465	19,655	64,476	11,438	75,914
Scenario II:						
1980-85	-23,504	-2,312	4,720	-21,096	2,924	-18,172
1980-90	-8,324	-895	8,119	-1,100	5,152	4,052
1980-95	6,856	631	11,930	19,417	7,627	27,044
Scenario III:						
1980-85	-23,504	-2,312	4,720	-21,096	2,924	-18,172
1980-90	24,796	1,721	16,050	42,567	7,379	49,946
1980-95	88,276	7,280	25,320	120,876	15,052	135,928
Total U.S. economy:						
Scenario I:						
1980-85	-55,865	-4,263	10,449	-49,679	4,224	-45,455
1980-90	13,015	360	25,497	38,872	9,587	48,459
1980-95	98,296	6,390	43,509	148,195	16,522	164,717
Scenario II:						
1980-85	-55,865	-4,263	10,449	-49,679	4,224	-45,455
1980-90	-19,785	-1,650	17,973	-3,462	7,442	3,980
1980-95	16,295	1,164	26,409	43,868	11,017	54,855
Scenario III:						
1980-85	-55,865	-4,263	10,449	-49,679	4,224	-45,455
1980-90	58,935	3,174	35,529	97,638	10,659	108,297
1980-95	209,815	13,425	56,049	279,289	21,742	301,031

1/ All indicated changes are cumlative and are derived from actual 1980 demand data.

Source: I/O Model of the U.S. economy.

Table 42.-- U.S. industry employment changes derived from I/O model and demand scenarios, 1985, 1990, and 1995 1/

(In thousands of jobs)

	Change in output related to:					
	Industrial chemicals sector	Agricultural chemicals sector	Plastics resins and synthetic rubber sector	Total commodity sectors	Specialty chemicals sector	Total effect of "shift"
Chemicals and allied products:						
Scenario I:						
1980-85	-158	-12	24	-146	25	-121
1980-90	37	1	59	97	57	154
1980-95	278	17	101	396	99	495
Scenario II:						
1980-85	-158	-12	24	-146	25	-121
1980-90	-56	-5	42	-19	44	25
1980-95	46	3	61	110	66	176
Scenario III:						
1980-85	-158	-12	24	-146	25	-121
1980-90	167	9	82	258	64	322
1980-95	593	37	130	760	130	890
Total U.S. economy:						
Scenario I:						
1980-85	-358	-21	36	-346	44	-299
1980-90	84	2	88	170	100	270
1980-95	629	31	150	810	172	982
Scenario II:						
1980-85	-358	-21	36	-343	44	-299
1980-90	-127	-8	62	-73	77	4
1980-95	104	6	135	245	115	360
Scenario III:						
1980-85	-358	-21	36	-343	44	-299
1980-90	377	16	181	574	111	685
1980-95	1,344	66	285	1,698	262	1,921

1/ All indicated changes are cumlative and are derived from actual 1980 demand data.

Source: I/O Model of the U.S. economy.

FIGURE 15.--SHARE OF CHEMICALS AND ALLIED PRODUCTS INDUSTRY

REPRESENTED BY COMMODITY PETROCHEMICALS AND SPECIALTY CHEMICALS, 1980

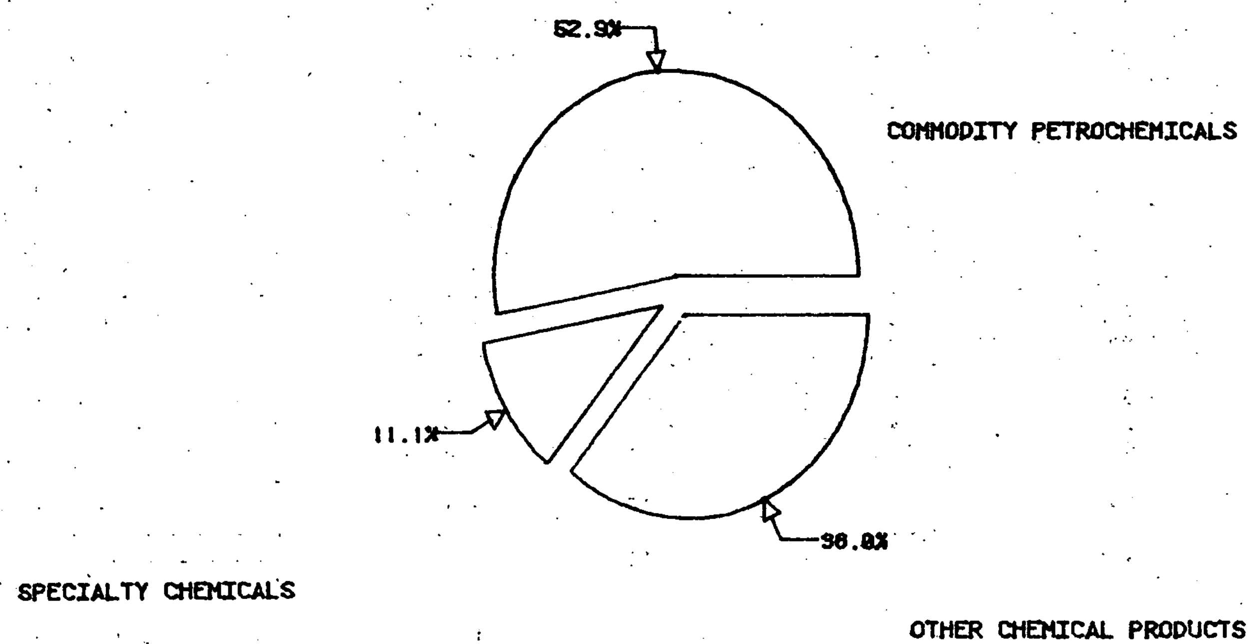


FIGURE 16.--SHARE OF CHEMICALS AND ALLIED PRODUCTS INDUSTRY REPRESENTED BY COMMODITY PETROCHEMICALS AND SPECIALTY CHEMICALS, AS PROJECTED BY THE DEPARTMENT OF LABOR I/O MODEL, 1985

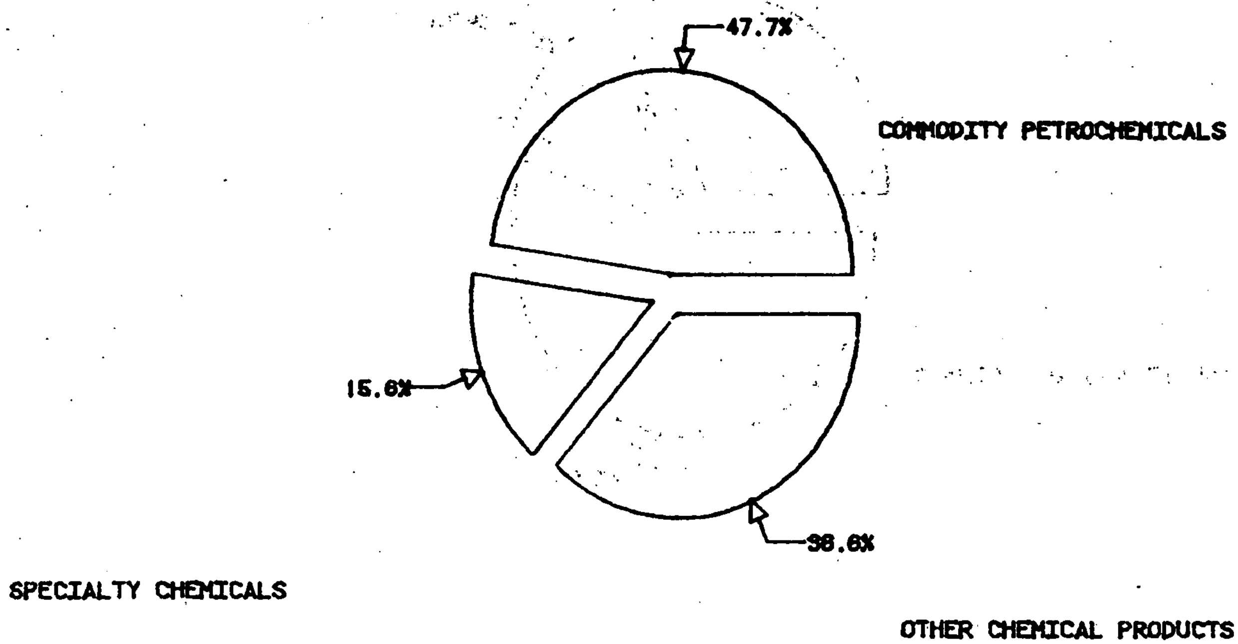


FIGURE 17.--SHARE OF CHEMICALS AND ALLIED PRODUCTS INDUSTRY REPRESENTED BY COMMODITY PETROCHEMICALS AND SPECIALTY CHEMICALS, AS PROJECTED BY THE DEPARTMENT OF LABOR I/O MODEL, 1990

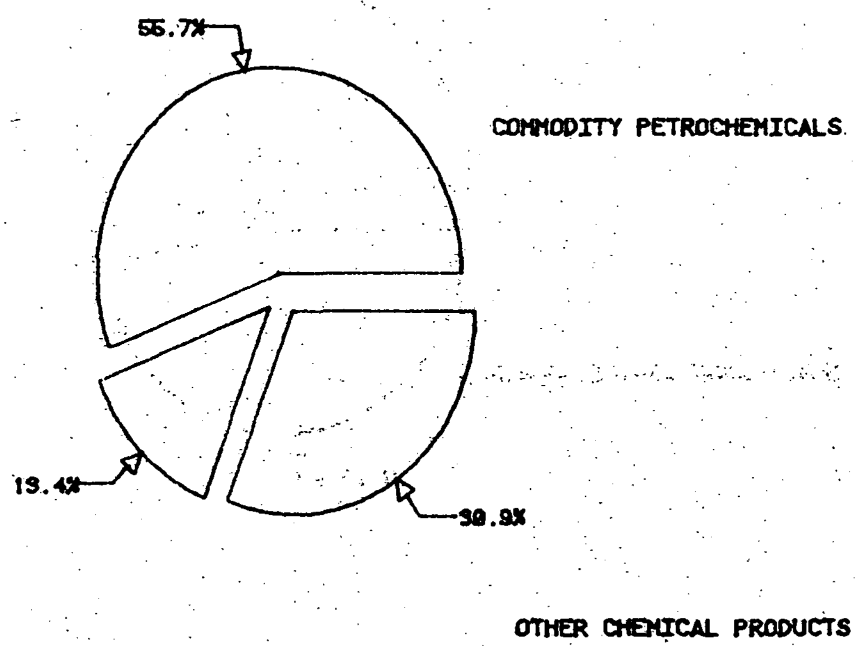
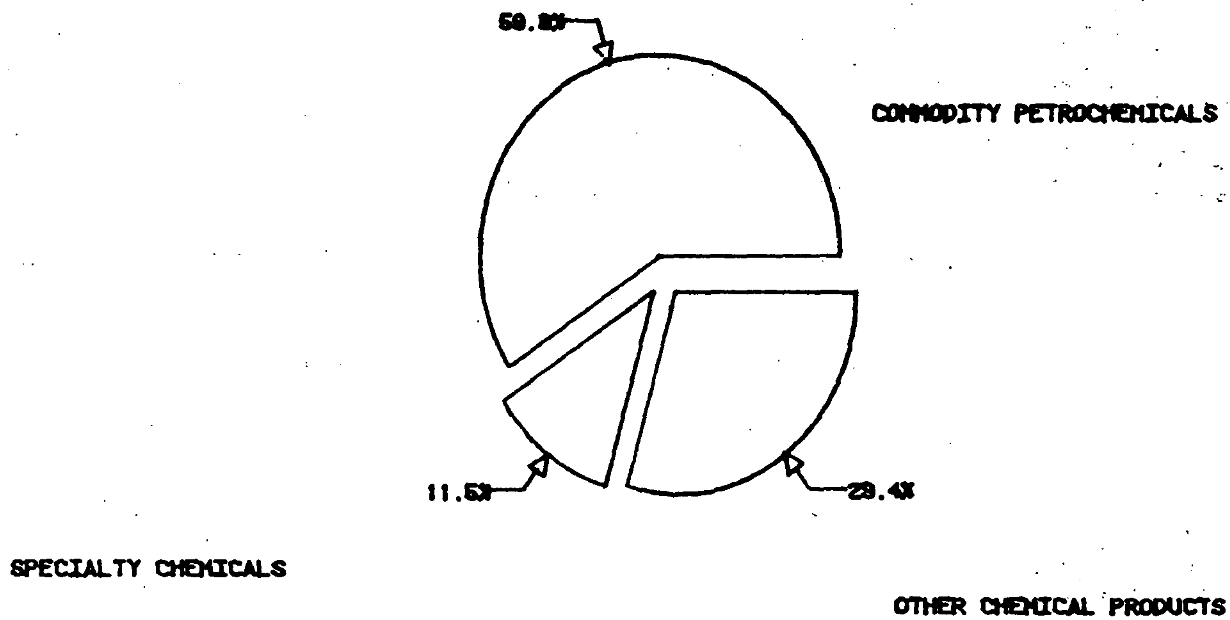


FIGURE 18.--SHARE OF CHEMICALS AND ALLIED PRODUCTS INDUSTRY REPRESENTED BY COMMODITY PETROCHEMICALS AND SPECIALTY CHEMICALS, AS PROJECTED BY THE DEPARTMENT OF LABOR I/O MODEL, 1995



In 1995, output from the chemicals and allied products industry is projected to increase by between $27.0 billion and $135.9 billion, from the 1980 values. Employment for this industry is projected to increase by between 176,000 and 890,000 jobs during 1980-95. Overall U.S. economic output for 1995 is projected to increase by between $54.9 billion and $301.0 billion during 1980-95, and total employment is projected to increase by between 360,000 and 1.9 million jobs.

Figure 15 shows the relationships among the primary industry sectors which comprise the chemicals and allied products industry, as of 1980. Figures 16-18 show the anticipated relationships according to the base scenario projections of the I/O model for 1985, 1990, and 1995. While the share of the chemicals and allied products industry held by the commodity petrochemicals sector is anticipated to decline from 53 percent in 1980 to 48 percent in 1985, the overall size of this sector allows it to regain an increased share of the chemicals and allied products industry, despite the slower growth rate expected for this sector during 1985-95. The share of the industry held by specialty chemicals is anticipated to increase initially from 11 percent in 1980 to an expected 16 percent in 1985, and then decline to approximately 12 percent by 1995.