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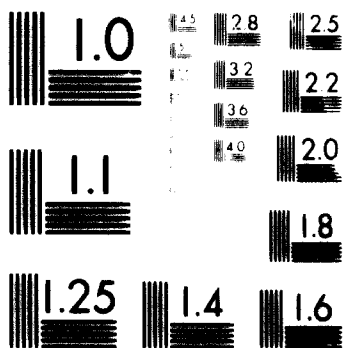
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Report

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The Economist Intelligence Unit

INDUSTRIAL DEVELOPMENT SURVEY

CHEMICALS, PETROLEUM AND COAL PRODUCTS

November 1970

**THE ECONOMIST INTELLIGENCE UNIT LIMITED,
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INDUSTRIAL DEVELOPMENT SURVEY

CHEMICALS, PETROLEUM AND COAL PRODUCTS

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INTRODUCTION

Background to Recent Developments in the Chemical Industry

The development of the world chemical industry can be divided into fairly distinct stages both from the point of view of raw material inputs and the technologies employed. In the earliest stages crude minerals such as sulphur and salt were converted into chemicals for use in other industries. Sulphuric acid for example was derived from sulphur for use in fertiliser production. This was followed by the development of products based on natural organic chemicals from coal, wood and similar materials. Amongst these were the extraction of ethyl alcohol from molasses, methyl alcohol from wood, cellulose from cotton and materials incorporating the benzene ring structure from coal tar. The fixation of atmospheric nitrogen by direct ammonia synthesis marked the beginning of a new era in the chemical industry leading to the development of a large-scale fertiliser industry.

The latest and perhaps the most spectacular stage has involved the cracking of mineral oils and gas to produce chemical building blocs such as ethylene, propylene and butylene and the production of synthetic organic chemicals with complicated molecular structures. The development of petroleum and natural gas reserves has resulted in coal based chemical industries being forced to change their basic raw material, the fertiliser industry being a good example.

The scale of operations in the petroleum industry is usually much larger than that in the chemical industry with the result that the quantity of materials used in an individual chemical unit is often less than one tenth of that used in a refinery. The development of the petro-chemical industry has, therefore, resulted in a rapid increase in plant size and a growing number of chemicals produced from a given feedstock source. The economies of scale inherent in a modern petro-chemical industry requires the simultaneous creation of a large number of inter-connected production units. These in turn require markets larger than those usually to be found in the developing countries.

The petrochemical industry is highly capital intensive and has little requirement for unskilled labour, the factor in most abundant supply in the developing countries.

The post-1945 era has seen significant changes in the demand structure for chemicals and this is largely linked with the development of high polymers. The rapid development of high polymer technology is closely connected with the growth of the petrochemical industry. The new synthetic fibres such as nylon, acrylics and polyesters have encroached upon the markets previously held by traditional textiles. Synthetic plastics such as polyethylene, polypropylene, polystyrene and polyvinyl chloride have also eaten into the markets for traditional materials as well as creating completely new consumer demands. New synthetic rubbers such as SBR, polybutadiene and polysoprene have replaced natural rubber in many markets.

Petro-chemicals have provided the impetus for the rapid growth of the chemical industry during the past twenty years. In the United Kingdom, whose chemical industry is similar in structure to those in many of the leading industrial countries, it has been estimated that basic organic chemical production alone increased its share of total chemical production from one-seventh in 1954 to one-fifth in 1968. A different measure of the relative importance of petro-chemicals in the chemical industry is to add to the basic organics the end-products which are derived from them. By this measure well over half of the chemical industry in the developed market economies is in effect a petro-chemical industry. If synthetic textiles are added, the proportion is even higher.

The Chemical Industry and the Developing Countries

The growing sophistication of modern chemical processes, particularly as related to the petro-chemicals industry, has placed increasing emphasis on having a large scale of operations as a prerequisite for commercial success. The significance of this for the developing countries has been well illustrated in studies carried out by the Economic Commission for Latin America. From these studies, which examine

the relationship between per capita income and per capita consumption, UNIDO calculated the size of market required at given income levels to absorb the production at the minimum economic scale for particular chemical products. Thus for sodium hydroxide, for example, with per capita incomes at \$100 a market of 36 million people is required to absorb the minimum economic plant capacity of 20,000 tons a year. For synthetic rubber a market of 90 million people is required if per capita incomes are only \$100. If per capita incomes are higher, the size of market is, naturally, correspondingly lower. In general the heavy organic chemicals require a considerable scale of operations for their production to be economical, but the requirements for certain end-products such as paints, varnishes, waxes and certain pharmaceuticals are less stringent.

Another major problem for the developing countries is the fact that the chemical industry requires large inputs of the most scarce factors, capital (resulting in a drain on limited reserves of foreign currency) and small inputs of labour which in unskilled form is generally readily available.

The demanding requirements in terms of large markets, high capital inputs and low inputs of unskilled labour help to explain why so few developing countries can support a fully fledged petro-chemical industry. The higher per capita income levels and the relatively large populations of the industrially more advanced Latin American states such as Mexico, Argentina, Brazil and Venezuela also help to explain why the chemical industry in this region is considerably more advanced than in Asia and Africa.

This Survey

This report covers the group of products defined in ISIC product groups 31-32. In the field of chemicals there are considerable difficulties in the presentation of comparable statistics on a world wide basis, thus the UNIDO statistics on output and employment cover both chemicals and petroleum products whilst statistics on the trade of the developing countries produced by UNCTAD refer only to chemicals. Several reports produced by U.N. agencies in recent years contain statistics on the

chemicals industries but seldom in the required form or for the required socio-economic and geographical groupings. Another major problem is that in even the most up-to-date reports on the chemical industry statistical coverage for the developing countries seldom extends beyond the mid-1960's. It has been necessary, therefore, to study trends on a rather longer-term basis than the period originally requested since meaningful data for the years 1967-69 is not available.

The terms of reference, together with regional definitions, are included in the volume "General Industrial Review".

INDUSTRIAL DEVELOPMENT SURVEY

CHEMICALS, PETROLEUM AND COAL PRODUCTS

ASIA

Economic Trends

Data on economic trends in the Asian petro-chemical industries are presented in Appendices I-IV, where output, employment and value added per person are given.

Output. Asia accounts for just over 35 per cent of the developing countries' output of petro-chemical products in value terms. This proportion has not changed significantly during the past decade. As a proportion of total world output, however, Asia's share at less than 3 per cent is insignificant. Between 1960 and 1969 the growth of output of petro-chemicals has been marginally slower in Asia than in the other developing regions. During this period the average annual increase in Asian output at 7.6 per cent was the slowest of any region, but growth since 1965 has been more rapid.

The more important Asian producers of petro-chemical products are shown in Table 1.

Table 1. Asia - Output in the Petro-Chemical Industries

	1960		1968	
	Value (U. S. \$ mn)	Per Cent of Total	Value (U. S. \$ mn)	Per Cent of Total
Total	1,306	100	2,347	100
of which:				
India	334	26	690	29
China (Taiwan)	32	3	148	6
Korea	28	2	162	7
Philippines	104	8	155	7
Indonesia	190	15	183	8
Iran	176	14	225	10
Others	439	32	784	33

Source: UNIDO

India is the largest producer by a considerable margin. The six largest producer countries produce two thirds of Asia's total output in value terms. Whilst India's output has more than doubled during the decade, the rate of increase in output in the Philippines, India and Iran has been slow by petro-chemical industry standards. In South Korea and China (Taiwan) progress has been exceptionally rapid.

Employment. Employment in the petro-chemical industries in Asia increased by just under 50 per cent between 1960 and 1967, the latest year for which figures are available. Output increased by around 60 per cent during the same period. The implied growth in labour productivity in the region is low by petro-chemical industry standards. The value added per person engaged in the petro-chemical industries in Asia remained below \$2,000 throughout the period, a level considerably below those attained in the other developing regions.

Trade. Asia is a net importer of both chemical and petroleum products. Imports are mainly from the developed market economies and the small volume of exports from Asian sources is generally destined for other Asian countries. The major identified exporters of chemical products in Asia are China (Taiwan), Malaysia, Hong Kong, India and Pakistan.

Table 2. Asia - Trade in Chemical Products
(U. S. \$ million)

	Imports		Exports		Net Imports(-)/Exports(+)	
	1960	1967	1960	1967	1960	1967
Asia	61	134	61	134	-	-
Latin America	0	6	0	3	0	- 3
Africa	4	12	2	8	- 2	- 4
Developing countries	65	154	63	146	- 2	- 8
Developed Market						
Economies	785	1,465	37	86	-748	-1,379
of which:						
Europe	490	705	18	41	-472	- 664
North America	188	425	9	14	-179	- 411
Japan	105	321	4	20	-101	- 301
Centrally Planned						
Economies	26	86	6	10	- 20	- 76
World	875	1,710	108	245	-767	-1,465

Source: UNCTAD 'Handbook of International Trade and Development Statistics,' 1969.

The developed market economies supply 85 per cent of the chemical products imported into Asia. Between 1960 and 1967 Japan and, to a lesser extent, North America gained ground at the expense of Western Europe in the Asian import market, but Western Europe still remains the most important supplier of chemical products.

Consumption. Whilst consumption of chemicals more than doubled in Asia during the 1960's, per capita consumption in the region remained the lowest in the world.

Table 3. Asia - Apparent Consumption of Chemicals
(U.S. \$ million)

<u>Country</u>	<u>Total Consumption</u>			<u>Per Capita Consumption (\$)</u>		
	<u>1960</u>	<u>1965</u>	<u>1970^e</u>	<u>1960</u>	<u>1965</u>	<u>1970</u>
Total	1,672	2,694	3,843	1.9	3.6	3.4
Of which:						
China (Taiwan)	112	265	436	10.6	21.4	31.1
India	739	1,232	1,615	1.7	2.5	3.0
Pakistan	81	166	233	0.9	1.6	2.2
Philippines	166	262	310	6.1	8.1	8.1
Republic of Korea	104	168	220	4.3	5.9	6.7
Iran	67	138	167	3.1	5.6	6.3
Turkey	90	142	190	3.2	4.0	5.4
Others	313	521	672			

e. Estimated.
Source: UNIDO.

The fastest growing markets for chemicals were in China (Taiwan), where per capita consumption is nearly ten times the regional average, and in Pakistan. India accounts for about 42 per cent of Asia's chemical consumption, but its per capita consumption remains below the regional average.

Technological Trends

Types of Product. The emphasis in chemical production in Asia has been on inorganic industrial chemicals and fertilisers. Output of soaps and detergents is relatively much less important than in Africa, but pharmaceuticals and man-made fibres make up a higher proportion of total output than in Africa. As a component of total output organic industrial chemicals are insignificant by comparison with the developed market economies.

Value Added Per Person Employed. The value added per person employed in the chemical industry in Asia is lower than in any other region and has remained virtually static during the 1960's. In 1967 it was only just over 70 per cent of the African level and 40 per cent of the Latin American level.

Investment Trends

The main emphasis of investment in petro-chemicals in the Asian region is now increasingly concentrated in the oil-exporting countries of the Middle East. With the exception of Iran, and to a lesser degree Iraq, and Saudi Arabia, the oil-exporting states have only limited domestic markets and their aim is to export chemical raw materials. This is seen as being one way in which they can reduce their reliance on a single product - crude oil - and take advantage of their raw material resources.

Five Persian Gulf States have planned, or are planning fertiliser plants - Iran, Kuwait, Saudi Arabia, Qatar and Iraq. It has been estimated that by 1968 the total capacity installed in four of these countries (excluding Qatar) was 700,000 metric tons of ammonia, 720,000 metric tons of urea and 295,000 metric tons of other nitrogenous fertiliser. In addition, a million tons of sulphur capacity was in place, and there were substantial expansion schemes in all these fields. A recent Chemical Age Survey of export contracts showed that the Middle East was second only to Latin America with 90 orders worth \$1,310 million.

Future Prospects. Asian output was growing more rapidly in the period since 1965 than during the first half of the decade and this trend is expected to continue into the early 1970's. On the assumption of relatively stable political conditions in the middle east output is expected to rise to around \$3,720 million by 1973, which would show an annual rate of increase of 10 per cent over 1970. Value added per person employed in the industry is not expected to increase significantly up to 1973, and employment in the industry is unlikely to exceed 1.85 million.

LATIN AMERICA

Economic Trends

The basic statistical data for this section are included in Appendices I-IV where output, employment and value added per person are given on a comparable basis with that of other socio-economic groupings.

Output. Latin America has the largest output of petro-chemical products of any of the developing regions. The output of the petro-chemical industries in 1969 was \$4,142 million, nearly 60 per cent of total output in the developing countries. The major producers of petro-chemical products within the region are Brazil, Mexico and Argentina. In 1968 these three countries accounted for around 70 per cent of total Latin American output. These countries are amongst the most industrially advanced nations in the developing world.

Table 4. Latin America - Output in the Petro-Chemical Industries

	<u>1960</u>		<u>1968</u>	
	<u>Value</u> <u>(U.S. \$ mn)</u>	<u>Per Cent</u> <u>of Total</u>	<u>Value</u> <u>(U.S. \$ mn)</u>	<u>Per Cent</u> <u>of Total</u>
Total	2,034	100	3,872	100
Of which:				
Argentina	537	26	939	24
Brazil	418	21	969	25
Chile	99	5	137	4
Colombia	96	5	142	4
Mexico	368	18	849	22
Venezuela	199	10	310	8
Others	317	15	526	13

Source: UNIDO.

Between 1960 and 1969 the growth of output in the Latin American petro-chemical industries was marginally more rapid than in Asia and Africa, but slower than in the developed market economies. The average annual rate of increase for the region as a whole was just over 8 per cent, but in certain countries, notably Mexico and Brazil, considerably faster rates of growth were achieved.

Employment. The growth in employment in the petro-chemical industries in Latin America was significantly slower than in Asia and Africa. At the same time, it will be remembered, output increased slightly faster than in these regions. In terms of growth in employment and productivity the experience of the more advanced Latin American petro-chemical industries was closer to developments in the industrialised countries of North America, Europe and Japan than to developments in Asia and Africa. In 1967 the total number of people employed in the petro-chemical industries in Latin America was 714,000, over 350,000 fewer than in Asia, but the value added per employee was 150 per cent greater than in Asia and 80 per cent greater than in Africa.

Trade. Latin America's main trade in chemical products is with the developed market economies of Europe and North America. Western Europe replaced North America as the main source of imports between 1960 and 1967. The developed market economies accounted for around 90 per cent of all imports of chemical products into Latin America during this period. The bulk of chemicals production is for domestic consumption and in spite of rising production, exports remain small. However, exports to countries within the region have grown very rapidly and this has to some extent compensated for the slow growth of exports to the developed market economies, notably North America. Trade in chemical products with developing countries outside Latin America is of negligible importance.

Although intra-regional trade has grown rapidly during the 1960's, it remains very small compared with the value of net imports from the developed market economies as is shown in table 5.

Table 5. Latin America - Trade in Chemical Products
(U.S. \$ million)

	Imports		Exports		Net Imports(-)/Exports(+)		
	1960	1967	1960	1967	1960	1967	
Asia	0	3	0	6	0	+	3
Latin America	15	85	15	85	-		-
Africa	0	0	0	3	0	+	3
Developing Countries	15	87	15	94	0	+	7
Developed Market							
Economies	740	1,140	95	115	-646		-1,025
Of which:							
Europe	320	570	28	38	-292	-	532
North America	420	542	64	73	-356	-	469
Japan	7	27	2	3	-5	-	24
Centrally Planned							
Economies	24	55	3	25	-21	-	30
World	790	1,280	110	235	-660		-1,045

Source: UNCTAD 'Handbook of International Trade and Development Statistics', 1969.

Consumption. Latin America accounts for more than half of total consumption of chemicals in the developing countries. On a per capita basis, consumption is seven times greater than in Asia and over 5 times greater than in Africa. However, Latin American per capita consumption is still only just over 40 per cent of the world average.

Table 6. Latin America - Apparent Consumption of Chemicals
(U.S. \$ million)

Country	Total Consumption			Per Capita Consumption (\$)		
	1960	1965	1970 ^e	1960	1965	1970 ^e
Total	2,815	4,556	6,325	13.9	19.7	23.7
Of which:						
Argentina	410	720	1,018	19.8	34.0	41.9
Brazil	912	1,312	1,680	13.1	16.2	17.9
Mexico	697	1,282	1,904	19.4	30.0	39.2
Venezuela	225	381	495	30.9	43.8	47.6
Others	571	861	1,228			

e. Estimated.
Source: UNIDO.

The main markets for chemicals are in Argentina, Brazil, Mexico and Venezuela which between them account for around 80 per cent of total consumption in the region. The growth of consumption in the 1960's was marginally slower than in Asia but faster than in Africa.

Technological Trends

Types of Product. The Latin American chemical industry is rather more advanced than the chemical industries of Africa and Asia. As a result, the product mix bears a closer relationship to that found in the developed market economies than to the structure of output in the other developing regions. Organic industrial chemicals are relatively more important than in Africa and Asia. Inorganic base chemicals, however, form only a small part of total output and there is less emphasis on fertilisers, an indication that the industry has progressed well beyond the first stages of its development. Pharmaceuticals, soaps and detergents are relatively twice as important as in the developed market economies.

Value Added Per Person Employed. This increased by nearly 40 per cent between 1960 and 1967. Value added per employee is considerably higher than in Africa and Asia, but still only 60 per cent of the levels attained in Europe.

Investment

The petro-chemicals industries in Latin America are considerably more advanced than in most other parts of the developing world. Mexico and Argentina already possess petro-chemical industries of growing importance, and other countries such as Brazil, Venezuela, Peru, Colombia and Chile all have ambitious programmes for future development. Brazil is planning to meet a demand for petro-chemicals in 1976 of nearly 2 million tons of intermediate products and a million tons of finished products. A substantial proportion of this development will be based on local supplies of oil and natural gas. A recent Chemical Age survey of export contracts showed that Latin America with 123 orders worth \$1,960 million accounted for nearly 20 per cent of world export orders for chemical plant.

Future Prospects

Latin America will continue to set the pace in the developing world as a producer of chemicals. The chemical industry is already well established in Argentina and Mexico, but Brazil, Venezuela, Peru, Colombia and Chile all have ambitious programmes for future development. By 1973 total output should be just over \$5,630 million. The rising trend in value added per employee is expected to continue, and the increase in employment to around 940,000 will not be proportional to the growth of output.

AFRICA

Economic Trends

Data on economic trends in the African petro-chemical industries are presented in Appendices I-IV, where output, employment and value added per person are given.

Output. The petro-chemical industries in Africa are as yet in their infancy and output is very small even by comparison with Asia and Latin America. The output of chemical products is largely concentrated in North Africa and in particular in the United Arab Republic, Algeria and Morocco. Growth in the output of the petro-chemical industries was rapid between 1960 and 1966, but since then total output has fluctuated around a level of \$400 million, less than 6 per cent of total output in the developing countries. The disappointing performance since 1966 can probably be traced to the disruptions to the industry in the United Arab Republic caused by the military confrontation with Israel.

Employment. Growth in employment in the petro-chemical industries in Africa was more rapid than in any other part of the world during the 1960-67 period. This was largely due to the very low level of development of the industry in the base year 1960. During the period employment nearly doubled, from 75,000 in 1960 to 142,000 in 1967. Value added per person employed was higher than in Asia but less than 60 per cent of the level attained in Latin America in 1967.

Trade. Africa has a much smaller trade in chemical products than either Asia or Latin America. The growth in Africa's trade in these products was also slower between 1960 and 1967. By 1967 imports had increased to only \$660 million, less than 40 per cent of Asia's imports and only just over 50 per cent of Latin American import level. African exports doubled during the 1960-67 period to \$115 million.

Table 7. Africa - Trade in Chemical Products

(U.S. \$ million)

	Imports		Exports		Net Imports(-)/Exports(+)	
	1960	1967	1960	1967	1960	1967
Asia	2	8	4	12	+ 2	+ 4
Latin America	0	3	0	0	0	- 3
Africa	16	29	16	29	-	-
Developing Countries	18	40	20	41	+ 2	+ 1
Developed Market						
Economies	405	590	38	59	-367	-531
Of which:						
Europe	360	490	29	49	-331	-441
North America	21	55	5	6	- 16	- 49
Japan	1	4	0	1	- 1	- 3
Centrally Planned						
Economies	18	28	0	15	- 18	- 13
World	440	660	58	115	-382	-545

Source: UNCTAD 'Handbook of International Trade and Development Statistics'.

Around 90 per cent of Africa's imports of chemical products come from the developed market economies, mainly Western Europe. The bulk of Africa's small trade with the developing countries is intra-regional rather than with Asia and Latin America.

Consumption. Nearly half the chemicals consumed in Africa are used in one country, the United Arab Republic. Per capita consumption in the United Arab Republic is comparable with Latin American levels, but elsewhere in Africa per capita consumption is low even by developing country standards.

Table 8. Africa - Consumption of Chemicals

(U.S. \$ million)

	Total Consumption			Per Capita Consumption		
	1960	1965	1970 ^e	1960	1965	1970 ^e
Total	699	1,104	1,442	2.7	3.8	4.3
Of which:						
United Arab Republic	302	532	690	11.7	18.0	20.0
Others	397	572	752	1.7	2.2	2.5

e. Estimated.

Source: UNIDO.

During the 1960's the annual growth in chemical consumption in Africa has been around 7.5 per cent. Consumption in the United Arab Republic has increased more rapidly than in the rest of the region.

Technological Trends

Types of Product. African output of chemicals is mainly concentrated in the United Arab Republic where there is a strong emphasis on inorganic industrial chemicals and fertilisers. Soaps and detergents are probably relatively more important than in other developing regions. The importance of fertilisers will increase still further when Algerian production comes fully on-stream.

Value Added Per Person Employed. Value added per employee in Africa (mainly the United Arab Republic) is higher than in Asia but only 55 per cent of the Latin American level. It is not possible to detect any marked increase in value added per employee between 1960 and 1967.

Investment

During the 1960's the bulk of investment in the petro-chemical industries in Africa was concentrated in the United Arab Republic, the region's main producer and consumer of petro-chemical products. The main emphasis is now moving further west to Algeria where investments in petro-chemicals are expected to absorb well over one third of the investment allocations in the country's 1967-73 industrialisation plan. Three large petro-chemical complexes are being built, two based upon fertilisers and a third on plastics and PVC. One of these, a nitrogenous fertiliser plant at Arzew, has already come on stream and a second, a phosphate fertiliser plant at Annaba, is due for completion by 1971. Initially Algerian demand will not be able to absorb a large part of the output and there will be substantial surpluses for export.

Elsewhere in Africa the petro-chemical industry is in its infancy and investment has been modest. The growth of oil production in West Africa has been growing rapidly and the establishment of a petro-chemical complex in Nigeria has been under discussion for some time.

Future Prospects

The output of the chemical and petroleum products industry will continue to be dominated by the United Arab Republic but not to the same degree as in the 1960's. Algeria will become an increasingly important producer and in the early 1970's is likely to provide the main growth element in the region's output. In the more distant future the emergence of Nigeria as a centre of production is also in prospect. By 1973 total African output will be around \$500 million which implies a somewhat slower rate of growth than in Latin America and Asia. Total employment is unlikely to exceed 170,000 by 1973.

DEVELOPING COUNTRIES - SUMMARY

During the 1960's the chemical industry in the developing countries grew more slowly than in the developed market economies and centrally planned economies. Only in the industrially more advanced countries of Latin America does the structure of the industry show signs of having advanced beyond the early stages of development. It is unlikely that the developing countries will increase their relative importance as producers by 1973, indeed it is more than possible that they will account for a marginally smaller proportion of world output than in 1969. The small increase in employment will do little to alleviate the considerable unemployment in the developing countries, since skilled labour, which is most in demand in the chemical industry, is unlikely to be part of the unemployed in any case.

Although few individual developing countries have the required domestic market and technological resources to support a chemical industry, many of those countries have the necessary raw materials which are generally exported in crude form. Political pressure for the local processing of raw materials such as crude oil and natural gas is likely to grow, but trade between the developing countries will have to grow much more rapidly than in the past, possibly through regional co-operation, if markets of the necessary size are to be found.

Forecasts of output of chemicals in the developing countries in 1970 and 1973 are set out in the following table.

Table 9. Developing Countries -
Output of the Petro-Chemical Industries, 1970-73
(U. S. \$ million)

<u>Region</u>	<u>1970</u>	<u>1973</u>
Asia	2,800	3,720
Latin America	4,475	5,635
Africa	420	500
Developing Countries	<u>7,690</u>	<u>9,855</u>

Source: E. I. U. estimates.

DEVELOPED MARKET ECONOMIES

Economic Trends

Data on economic trends in the petro-chemical industries in the developed market economies are presented in Appendices I-IV, where output, employment and value added per person are given.

Output. The developed market economies account for approximately 70 per cent of the world's output of petro-chemical products. Between 1960 and 1968 output increased at an annual rate of 10 per cent. In Japan, however, the annual rate of growth was 14 per cent and in North America it was just over 7 per cent. In spite of its slower than average rate of growth, North American output of petro-chemical products still accounted for just over half the total output in value terms in the developed market economies.

Table 10. Developed Market Economies -
Output of the Petro-Chemical Industries

	1960		1968	
	Value (U.S. \$ mn)	Per Cent of Total	Value (U.S. \$ mn)	Per Cent of Total
Total	28,903	100	56,822	100
Of which:				
North America	16,384	57	29,072	51
Europe	10,249	35	21,822	38
Japan	1,693	6	4,830	9
South Africa	154)		292)	
Others	423)	2	806)	2

Source: UNIDO.

Employment. Between 1960 and 1968 employment increased by less than 2 per cent per annum and since 1966 it has been virtually static. Total employment in the petro-chemical industries in the developed market economies was just over 4.6 million in 1967 and 1968. With just under 52 per cent of the world's labour force in petro-chemical industries, the developed market economies accounted for around 70 per cent of world output.

Value added per person employed is nearly four times the level attained in the developing countries. Even within the developed market economies there are substantial differences in productivity between North America, Europe and Japan. Although Europe and Japan have been catching up on North America in terms of productivity, value added per person employed is still less than half the North American level.

Trade. The movement of petro-chemical products between the developed market economies accounts for over 70 per cent of total world trade in these products. Trade between the developed market economies and the developing countries accounts for a further 15 per cent of world trade. The value of trade in which the developed market economies are involved is over 90 per cent of the total value of world trade.

Within the developed market economies intra-European trade is considerably more important than other trade flows. North America has an adverse balance of trade in petro-chemical products with Europe and Japan.

Table 11. Developed Market Economies - Trade in Chemical Products
(U.S. \$ million)

	<u>Imports</u>		<u>Exports</u>		<u>Net Imports(-)/Exports(+)</u>	
	<u>1960</u>	<u>1967</u>	<u>1960</u>	<u>1967</u>	<u>1960</u>	<u>1967</u>
Asia	37	86	785	1,465	+ 748	+1,379
Latin America	94	115	740	1,140	+ 646	+1,025
Africa	38	59	405	590	+ 367	+ 531
Developing Countries	175	305	2,020	3,360	+1,845	+3,055
Developed Market Economies	4,170	8,760	4,170	8,760	-	-
Of which:						
Europe	2,820	6,390	2,940	6,450	+ 120	+ 60
North America	1,155	2,060	690	1,250	- 465	- 810
Japan	50	200	225	485	+ 175	+ 285
Other	145	110	315	575	+ 170	+ 465
Centrally Planned Economies	165	319	263	795	+ 98	+ 480
World	4,510	9,380	6,550	12,960	+2,040	+3,580

Source: UNCTAD 'Handbook of International Trade and Development Statistics, 1969'.

Consumption. The developed market economies account for two-thirds of total world consumption of chemicals. Japanese consumption increased extremely rapidly at over 15 per cent per annum, but elsewhere annual rates of growth were nearer 9 per cent.

Table 12. Developed Market Economies - Consumption of Chemicals
(U.S. \$ million)

<u>Year</u>	<u>North</u>				<u>Total</u>
	<u>Europe</u>	<u>America</u>	<u>Japan</u>	<u>Others</u>	
1963	23,905	30,985	4,515	2,150	61,555
1964	26,365	33,615	4,735	2,393	67,108
1965	28,710	36,280	5,860	2,616	73,466
1966	31,420	41,155	6,650	2,874	82,099
1967	34,780	42,685	8,210	3,085	88,760
Average annual increase % p. a.	9.8	8.4	15.0*	9.4	9.6

Source: UNIDO; OECD; E. I. U. estimates.

Technological Trends

Types of Product. The most rapid growth in consumption and output of chemicals in the developed market economies has been in the field of basic organic chemicals and plastics. Estimates made by UNIDO for the early 1960's showed that basic organic chemicals accounted for 15 per cent of total production and plastics accounted for a further 10 per cent. Both of these product groups are now relatively more important. Similar estimates covering the early 1960's in Latin America, the only developing region for which adequate data was available, showed that these two product groups represented only just over 14 per cent of total output.

An important feature of the chemical industry in the developed market economies during the 1960's has been the accelerating trend towards large, automated plants and the resulting rapid rise in productivity. The growing size of new chemical plants and the economies of scale resulting from larger units has led to an increasing number of mergers among chemical firms and the creation of joint investments and joint subsidiaries.

The increasing size of production units also means that the penalties from running them at well below capacity are severe. This heightens the risk of short-term disequilibrium between supply and demand. Other problems arising from the trend towards larger production complexes include the transportation of raw materials and finished products and the disposal of waste products. Chemical plants have, therefore, increasingly been located near petroleum refineries, the source of the raw materials, at or near large ports. However, the problem of pollution arising from the disposal of waste products from the increasingly concentrated petro-chemical complexes is likely to become a major problem of the industry during the 1970's.

Value Added Per Person Employed. Between 1960 and 1968 value added per person employed in the petro-chemical industry in the developed market economies increased by 7 per cent per annum. The increase in Japan was well over double this level and in North America it was somewhat lower. Japan had caught up with Europe by 1967 and has since overtaken it, but both the European and Japanese levels of value added per employee are less than half the level attained in the United States.

Investment. Annual new investment in the chemical industry in the developed market economies rose from \$4,531 million in 1963 to \$7,596 million in 1968.

Table 13. Developed Market Economies -
Annual New Investment in the Chemical Industry
(U. S. \$ million)

	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>
Europe	2,255	2,563	2,990	3,516	3,418	3,416
North America	1,759	2,103	2,849	3,254	3,130	2,974
Japan	517	703	655	513	824	1,206
Total	<u>4,531</u>	<u>5,369</u>	<u>6,494</u>	<u>7,283</u>	<u>7,372</u>	<u>7,596</u>

Source: OECD.

As a percentage of value added by the chemical industry, new investment ranged from around 12 in North America to 22 in Europe and 25 in Japan. The trend in new investments in the developed market economies shows much wider fluctuations than movements in either value added or in manpower. Even in those countries with long

established chemical industries, the changes from year to year are considerable. The productivity of new investment in the chemical industry remains much higher in North America than in Europe and Japan.

Future Prospects

Output and consumption are expected to continue to increase rapidly with Japan leading the way. By 1973 Japanese output can be expected to be more than double its 1968 level. European output is expected to rise to just under \$35,000 million, around 40 per cent of the total output of the developed market economies. In view of the expected increase in value added per person employed to total number of people employed is unlikely to be significantly above 5 million.

CENTRALLY PLANNED ECONOMIES

Economic Trends

The main statistics relating to economic trends in the petro-chemical industries of the centrally planned economies are presented in Appendices I-IV.

Output. During the 1960's the centrally planned economies have expanded their output of petro-chemical products more rapidly than even the developed market economies. The average annual increase in output between 1960 and 1969 was over 12 per cent. The total value of output at \$20,438 million in 1969 was under a quarter of world output.

Employment. The growth of employment in the petro-chemical industries in the centrally planned economies has been faster than the world average. By 1967 total employment was just under 2 million and marginally higher than the level of employment in the developing countries. Value added per employee was consistently above European levels between 1960 and 1967 but well below the levels attained in North America.

Trade. The centrally planned economies play a relatively small part in world trade in petro-chemical products, being involved in only 12 per cent of world trade in 1967. Around 50 per cent of their trade is with each other, and the balance is mainly with western Europe with whom they have an adverse trade balance.

Table 14. Centrally Planned Economies - Trade in Chemical Products
(U.S. \$ million)

	<u>Imports</u>		<u>Exports</u>		<u>Net Imports(-)/Exports(+)</u>	
	<u>1960</u>	<u>1967</u>	<u>1960</u>	<u>1967</u>	<u>1960</u>	<u>1967</u>
Asia	6	10	28	86	+ 20	+ 76
Latin America	3	25	24	55	+ 21	+ 30
Africa	0	15	18	28	+ 18	+ 13
Developing Countries	9	50	60	169	+ 50	+119
Developed Market Economies	263	795	165	319	- 96	-476
Of which:						
Europe	249	685	140	294	-100	-371
North America	6	23	14	7	+ 8	- 17
Japan	4	125	7	15	+ 3	-110
Centrally Planned Economies	<u>497</u>	<u>775</u>	<u>497</u>	<u>775</u>	<u>-</u>	<u>-</u>
World	<u>675</u>	<u>1,645</u>	<u>699</u>	<u>1,291</u>	<u>- 15</u>	<u>-394</u>

Source: UNCTAD 'Handbook of International Trade and Development Statistics, 1969'.

Consumption. There is little reliable information on the consumption of chemicals in the centrally planned economies. It is, however, possible to estimate the order of magnitude from data presented in the UNIDO monograph 'Chemical Industry' and in the OECD annual surveys of the chemical industry in the member countries. The UNIDO document presents estimates of the value of world chemical consumption in 1960, 1965 and 1970 (projected), together with a breakdown of consumption in the developing countries. The OECD annual surveys contain information on production and trade in most of the developed market economies and from these apparent consumption can be estimated. After deducting consumption in the developed market economies and the developing countries from the world total the residual value is assumed to relate to consumption in the centrally planned economies. On this basis, consumption rose from around \$20,300 million in 1960 to \$26,295 in 1965 and an estimated \$40,000 million - 1970; the implied average annual growth in consumption was 2 per cent.

Technological Trends

In the centrally planned economies of eastern Europe the production of inorganic industrial chemicals increased at faster rates than that of other chemical products during the 1950's, especially in those countries which were rebuilding their war ravaged industries. The past decade, however, has seen a rapid expansion of the organic chemical sector, largely as a result of the development of a petro-chemical industry.

The increase in the value added per person employed was just under 7 per cent per year between 1960 and 1967. Value added per employee is about 10 per cent above the average for western Europe, but the rate of increase has been marginally less rapid.

Investment

The extremely rapid growth of the chemical industry of the centrally planned economies of Eastern Europe was determined by a high level of investment necessitated by structural changes in the industry, especially towards the production of polymeric materials and the organic synthesis branch generally.

Table 15. Centrally Planned Economies - Investment in the Chemical Industry (U.S. \$ million)

	<u>1960</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>
U. S. S. R.	910.0	1,466.0	1,983.0	1,924.0	n. a.
Bulgaria	19.5	55.0	46.1	64.0	129.0
Czechoslovakia	2,073.4	2,147.4	2,287.8	2,315.0	2,565.0
Hungary	1,697.0	2,822.0	3,389.1	n. a.	3,190.0
Poland	4,178.4	6,191.3	6,288.0	7,056.0	n. a.
Romania	<u>1,621.0</u>	<u>3,399.0</u>	<u>n. a.</u>	<u>2,787.0</u>	<u>n. a.</u>
Total these Countries	<u>10,499.3</u>	<u>16,080.7</u>	<u>17,003.0^e</u>	<u>17,446.0^e</u>	<u>n. a.</u>

e. Estimated.

n. a. Not available.

Source: Economic Commission for Europe.

Future Prospects

The growth of the chemical industry in the centrally planned economies has been faster than in any other region or grouping during the past decade. Although there was some evidence of a slowing down in the rate of increase in output towards the end of the 1960's, growth up to 1973 is still likely to be the fastest in the world. The value of output in the chemical industry should reach \$31,000 million by 1973 but continued increases in value added per employee will keep total employment below 2.5 million.

WORLD - SUMMARY

The petro-chemical industry has been one of the most dynamic sectors of modern industry in the developed market economies, the centrally planned economies and in those developing countries in which it exists. World output increased at around 9.5 per cent throughout the 1960's. Between 1960 and 1965 output more than doubled but, because of rapid gains in productivity arising from the increasing size and sophistication of production units in the main producing centres, employment in the industry rose by only just over 25 per cent.

The relative importance of the developing countries as producers declined throughout the decade, and by 1969 they accounted for less than 8 per cent of world output. The developed market economies also lost ground marginally to the centrally planned economies, but they were still responsible for more than two-thirds of world output at the end of the decade. Within the developed market economies output in Europe and Japan increased significantly faster than in North America. The centrally planned economies increased their share of world output throughout the period and by 1973 they should produce nearly 25 per cent of the worlds' output.

Table 16. World Output of the Petro-Chemical Industries

	1960		1969		1973 ^e	
	Value (\$ mn)	Per Cent of Total	Value (\$ mn)	Per Cent of Total	Value (\$ mn)	Per Cent of Total
Asia	1,305	3.3	2,543	2.8	3,720	2.9
Latin America	2,034	5.1	4,142	4.6	5,635	4.4
Africa	195	0.5	395	0.5	500	0.4
Developing Countries	3,534	8.9	7,080	7.9	9,855	7.7
Europe	10,249	25.9	24,178	27.1	34,680	27.0
Developed Market Economies	28,903	72.9	61,834	69.2	87,620	68.2
Centrally Planned Economies	7,197	18.2	20,438	22.9	31,080	24.1
World	39,634	100.0	89,352	100.0	128,555	100.0

e. Estimated.

Source: UNIDO, E.I.U. estimates.

By its very nature, world production of chemicals tends to be concentrated in the major industrial countries. The growth of local chemical manufacture is inseparable from the growth of industry in the region as a whole. The highly capital intensive qualities of the industry lend themselves to high-wage countries with relatively advanced levels of technical education. Similarly the market for synthetic materials shows the fastest rate of growth in areas without access to cheap, indigenous raw materials such as rubber.

For these reasons, a very high proportion of world output of chemicals will continue to be found in the developed market economies and the centrally planned economies of eastern Europe over the next few decades. Rapid increases in the economies of scale will also continue to favour transporting a number of chemical products from one plant to many markets. However, the development of public attitudes on the problem of pollution arising from the disposal of waste products from large petro-chemical complexes could have a modifying effect on the trend towards further concentration.

Appendix I. Output by Region and Socio-Economic Grouping in the Chemicals, Petroleum and Coal Products Industries

(U.S. \$ millions)

	1960	1963	1964	1965	1966	1967	1968	1969
1. Asia	1,305	1,570	1,707	1,768	1,909	2,081	2,347	2,543
2. Latin America	2,034	2,605	2,851	3,032	3,264	3,406	3,872	4,142
3. Africa	195	278	325	376	405	379	413	395
4. Developing Countries ^a (Adjusted Total) ^c	3,534	4,453	4,883	5,176	5,576	5,866	6,632	7,060
5. Europe	10,249	13,358	15,072	16,404	18,030	19,342	21,822	24,178
6. Developed Market Economies	28,903	36,806	40,410	43,740	48,334	51,418	56,822	61,894
7. Centrally Planned Economies	7,197	10,428	11,757	13,297	14,947	16,771	18,616	20,438
8. World ^b	39,634	57,667	57,050	62,213	68,757	74,055	82,070	89,352

a. Total of 1+2+3. b. Total of 4+6+7. c. Including estimates for countries for which data is available.

Source: UNIDO.

**Appendix II. Indices of Production of
Chemicals, Petroleum and Coal Products Industries**
(1968 = 100)

	<u>1966</u>	<u>1969</u>	<u>Annual Average Growth Rate, 1966 - 1969</u>
Asia	122	162	10.0
Latin America	126	159	7.5
Africa	n.a.	n.a.	
Developing Countries	126	159	8.0
Europe	124	181	10.5
Developed Market Economies	120	166	8.0
Centrally Planned Economies	<u>142</u>	<u>196</u>	<u>11.4</u>
World	<u>122</u>	<u>172</u>	<u>9.6</u>

n.a. Not available.

Source: U.N. Monthly Bulletin of Statistics.

Appendix III. Industrial Employment in the Chemicals, Petroleum and Coal Products Industries by Region and Socio-Economic Grouping
('000 persons engaged)

	<u>1960</u>	<u>1963</u>	<u>1964</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>
1. Asia	719	867	900	1,011	1,031	1,066	n.a.
2. Latin America	500	603	600	641	663	714	n.a.
3. Africa	75	83	100	136	136	142	n.a.
4. Developing Countries ^a (Adjusted Total) ^c	1,394	1,573	1,600	1,786	1,852	1,924	n.a.
	1,406	1,601	1,719	1,830	1,865	1,953	n.a.
5. Europe	2,227	2,374	2,422	2,461	2,532	2,530	2,507
6. Developed Market Economies	4,027	4,322	4,406	4,427	4,618	4,657	4,633
7. Centrally Planned Economies	1,341	1,627	1,717	1,811	1,896	1,974	n.a.
8. World ^b	6,946	7,550	7,841	8,126	8,401	8,509	n.a.

a. Total of 1 + 2 + 3. b. Total of 4 + 6 + 7. c. Including estimates for countries for which data is unavailable.

Source: UNIDO.

Appendix IV. Values Added Per Person Engaged in the
Chemicals, Petroleum and Coal Products Industries by Region and Socio-Economic Grouping
(US \$ per person)

	1960	1963	1964	1965	1966	1967	1968
1. Asia	1,815	1,833	1,855	1,749	1,853	1,943	n.a.
2. Latin America	3,447	4,115	4,263	4,730	4,710	4,770	n.a.
3. Africa	2,000	3,349	3,250	2,765	3,104	2,669	n.a.
4. Developing Countries ^a	2,554	2,831	2,891	2,836	3,041	3,049	n.a.
5. Europe	4,002	5,037	6,223	6,612	7,121	7,045	8,704
6. Developed Market Economies	7,055	8,516	9,173	9,726	10,466	11,041	12,106
7. Centrally Planned Economies	5,307	6,400	6,947	7,343	7,875	8,496	n.a.
8. World ^b	5,043	6,046	7,276	7,654	8,104	8,633	n.a.

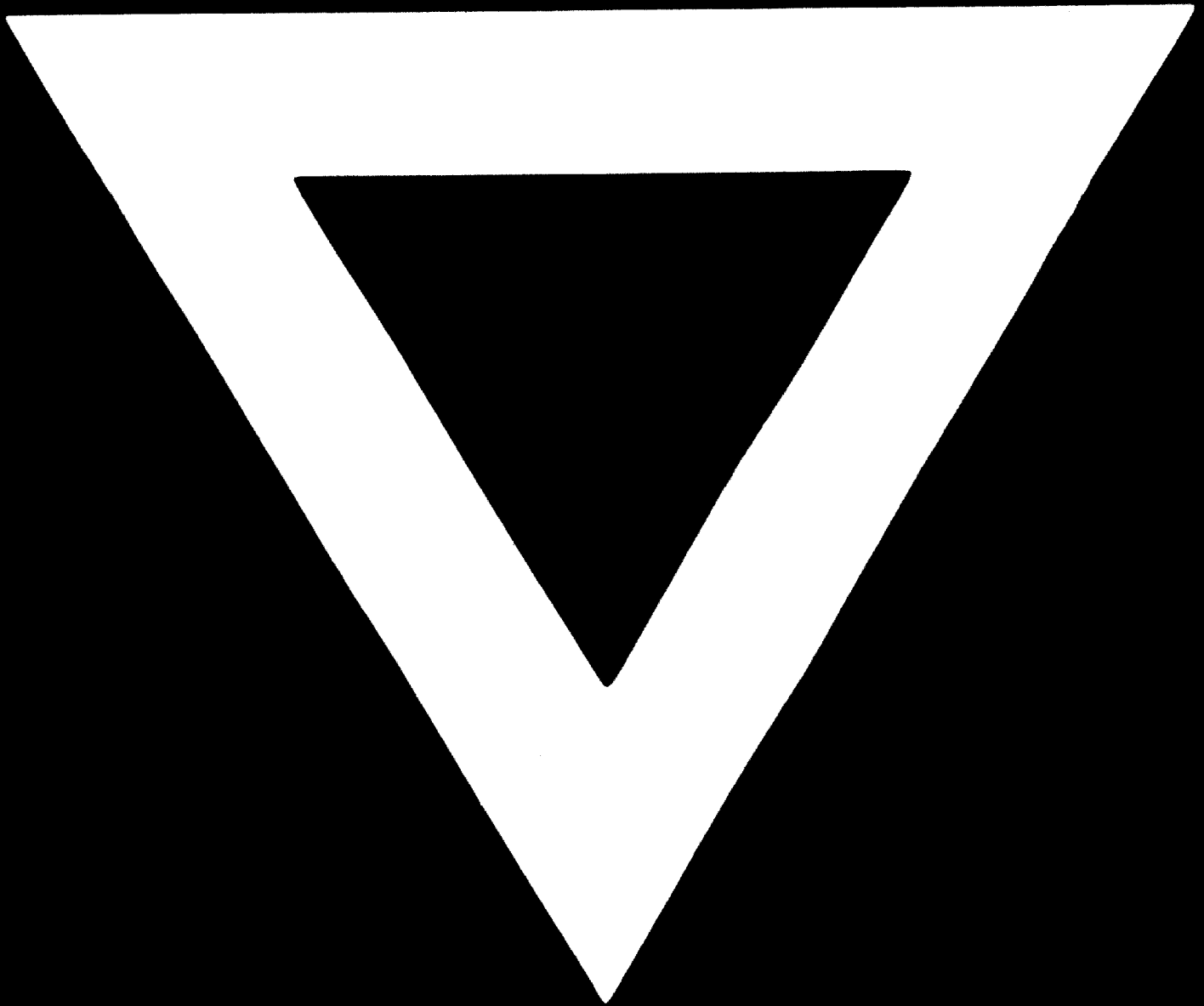
a. Total of 1 + 2 + 3. b. Total of 4 + 6 + 7.

n.a. not available

**Appendix V. Forecast Output by Region and Socio-Economic
Grouping in the Chemicals, Petroleum and Coal Products Industries**
(mn. US \$, constant prices)

	<u>1970</u>	<u>1973</u>	<u>Annual Average Growth Rate (Compound) (%) 1970 - 1973</u>
1. Asia	2,800	3,720	10.0
2. Latin America	4,475	5,635	8.0
3. Africa	420	500	6.0
4. Developing Countries	7,695	9,855	8.5
5. Europe	26,475	34,680	9.5
6. Developed Market Economies	67,400	87,620	9.0
7. Centrally Planned Economies	22,685	31,080	11.0
8. World	97,790	128,555	9.5

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