Rubber Handbook

Commodities and Export Projections Division
Economic Analysis and Projections Department

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I. THE CHARACTERISTIC OF THE PRODUCT

A. Physical

Natural rubber: **Natural rubber is a coherent elastic s .id obtained from a milky liquid known as latex which occurs in special vessels in the bark and in the roots, stem, branches, leaves and fruit of a wide assortment of plants growing, for the mc part, in the Tropics.**

2. **Natural ber of commerce is the product of a tree known as Hevea brasiliensis.** 1/ Although Brazil was the original home of the rubber tree, the main source of rubber comes from South and Southeast Asia.

3. The major constituent of the rubber from Hevea is a hydrocarbon with a chemical composition designated by the formula $(C_5 H_8)n$, where n represents a large but indefinite number of replications of the basic unit. The basic unit is generally considered to be isoprene, $C_5 H_8$, and thus the rubber hydrocarbon is a polyisoprene. This hydrocarbon is found in all natural rubbers and is responsible for their resilience and elasticity. The proportion of poly-isoprene varies in different crude rubbers; in Hevea it is over 90 percent. 2/

4. Natural rubber is a fairly homogenous commodity. Its qualities and product performance are well known: they still constitute the reference point for man-made elastomers. Natural rubber has high resilience and tensile strength and low heat build-up. Its resistance to impact, abrasion, and tear are excellent. Because of its physical and resistance properties, natural rubber

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1/ The other commercial source of natural rubber is provided by a desert shrub known as guayule, Parthenium argentatum Gray. It was the source of about 10% of the world's rubber supply in 1910 and contributed a substantial amount through the 1920s. During World War II, about 32,000 acres of guayule were planted in the US but most of the shrubs were destroyed after the war without recovering the accumulated rubber. With the so-called energy crisis, interest in guayule has revived, particularly in the US and Mexico.

2/ Hevea and guayule rubbers contain virtually identical cis-polyisoprene hydrocarbon but that from guayule lacks the natural vulcanization promoters and anti-oxidants present in Hevea-derived rubber.

is preferred for the manufacture of products that require high strength [1/] and low heat generation (e.g. airplane tires, giant truck tires, off-the-road vehicles' tires) and engineering products where high fatigue resistance is required. Natural rubber, however, is not very resistant to environmental factors: oxidation and ozone. It also has low resistance to chemicals: gasoline kerosene, benzol, degreasers, solvents, synthetic lubricants and hydraulic fluids.

5. The most common form of natural rubber initially produced by estates was "thin brown crepe", a grade similar to that bearing the same name today. The other premium grade was RSS (ribbed smoked sheet). There are six different grades of ribbed smoked sheets - RSS 1X to RSS 5, Table I-A1. The grades are based on visual inspection. RSS 1 is the highest grade traded, followed by RSS 2, RSS 3 and so on. Historically, RSS 1 was also the most widely traded grade of rubber. During the past two decades, its importance has diminished considerably particularly in relation to RSS 3, which is the standard type of natural rubber used in the manufacturing of tires. In addition to sheets, natural rubber is also traded as crepes. There are six standard types of crepes - pale, estate brown, thin brown, thick blanket, flat bark and pure smoked blanket. Each type of crepe, except the last one, is further subdivided into different grades. All rubber crepes, like sheets, are visually graded. [2/]

6. Ribbed smoked sheets are prepared from coagulated field latex. Estate brown, thin brown, thick blanket and flat bark crepes, on the other hand, are prepared from remilled ribbed smoked sheets.

7. The first serious effort to grade natural rubber on a technical basis was in 1949 with the starting of the TCR (Technically Classified Rubber) scheme.

1/ Guayule rubber lacks green strength, the characteristic which enables a radial tire to maintain its strength and shape under stress. As such, it is not considered suitable for radial tire manufacture without the addition of chemicals to improve its green strength.

2/ For more details on the production and grading of the different types of rubber see T.Y. Pee, "Technical Changes in Natural Rubber" (forthcoming).

Table I-A1: TRADITIONAL TYPES AND GRADES OF NATURAL RUBBER

Ribbed Smoked Sheets

- No. 1X - Superior Quality Ribbed Smoked Sheets
- No. 1 - Standard Quality Ribbed Smoked Sheets
- No. 2 - Good Fair Average Quality Ribbed Smoked Sheets
- No. 3 - Fair Average Quality Ribbed Smoked Sheets
- No. 4 - Low Fair Average Quality Ribbed Smoked Sheets
- No. 5 - Inferior Fair Average Quality Ribbed Smoked Sheets

Thick Pale Crepes:

- No. 1X - Superior Quality Thick Pale Crepe
- No. 1 - Standard Quality Thick Pale Crepe
- No. 2 - Fair Average Quality Thick Palish Crepe
- No. 3 - Fair Average Quality Thick Off-color Palish Crepe

Thin Pale Crepes:

- No. 1X - Superior Quality Thin Pale Crepe
- No. 1 - Standard Quality Thin Pale Crepe
- No. 2 - Good Fair Average Quality Thin Palish Crepe
- No. 3 - Fair Average Quality Thin Off-Color Palish Crepe

Estate Brown Thick Crepes:

- No. 1X - Clean Thick Light Brown Crepe
- No. 2X - Clean Thick Brown Crepe
- No. 3X - Brown to Dark Brown Thick Crepe

Estate Brown Thin Crepes:

- No. 1X - Clean Thin Light Brown Crepe
- No. 2X - Clean Thin Brown Crepe
- No. 3X - Brown to Dark Brown Thin Crepe

Thick Blanket Crepes (Ambers):

- No. 2 - Clean Thick Blanket Crepe (Amber)
- No. 3 - Clean Thick Blanket Crepe (Amber)
- No. 4 - Clean Thick Blanket Crepe (Amber)

Thin Brown Crepes:

- No. 1 - Clean Thin Superior Light Brown Crepe
- No. 2 - Clean Thin Light Brown Crepe
- No. 3 - Clean Thin Brown Crepe
- No. 4 - Thin Brown to Dark Brown Specky Crepe

Flat Bark Crepe:

- Standard Flat Bark Crepe
- Hard Flat Bark Crepe

Pure Smoked Blanket Crepes:

- Standard Quality Pure Clean Smoked Blanket Crepe

Source: Rubber Manufacturers Association, U.S.A.

However, it was not until the mid-1960s with the advent of new process block rubbers, which could not be graded by visual methods, that a comprehensive technical specification scheme encompassing both the packaging and its contents was started. The first such scheme to produce TSNR (Technically Specified Natural Rubber) was introduced by Malaysia in 1965 under the SMR (Standard Malaysian Rubber) scheme.

8. The SMR scheme started with three basic grades: SMR 5, SMR 20 and SMR 50. The primary specification criterion is cleanliness as measured by dirt content. Other undesirables - nitrogen, ash, copper, manganese and volatile matter - are also controlled to limits.

9. Since its inception the SMR scheme has been revised periodically. The first revision in 1970 introduced additional grades: SMR 5L (a light-color subgrade of SMR 5), SMR 5CV and SMR 5LV (viscosity-stabilized grades), SMR 10 (to cater for top quality estate caplump which was not permitted to be added to SMR 5) and SMR EQ (an extra-clean and light-colored rubber).

10. A second revision was carried out in 1979. The details of the SMR Scheme (1979) are given in Table I-A1. Following the example of Malaysia, other major natural rubber producing countries have also established TSNR schemes of their own: SIR (Standard Indonesian Rubber), TTR (Thai Tested Rubber), SSR (Specified Singapore Rubber), etc. The parameters and the specified limits of most of these schemes are closely patterned after those in the SMR scheme (see Table I-A2). One notable difference is that the SIR scheme has no specification for nitrogen. Although the Thai and Singapore schemes have specification levels for nitrogen, they are slightly higher than the maximum allowed under the SMR scheme for comparable grades.

11. Despite the fact that Indonesian TSNR production commenced much later than in Malaysia, its growth has been more rapid. The fact that most Indonesian smallholders produce slabs rather than collect field latex has encouraged this trend. It is apparently Indonesia's policy to eventually produce all its rubber in this form.

Table I-A2: SOME TECHNICALLY SPECIFIED NATURAL RUBBER SPECIFICATIONS

Property	Dirt content (max % wt)	Ash content (max % wt)	Nitrogen content (max % wt)	Volatile Matter (max % wt)	PRI (min)	Wallace Rapid plasticity min, initial value (P_o)	Colour limit Lovibond scale, max	Colour Code	Polythene wrapper colour	Polythene strip colour
INDONESIA										
SIR 5L[1]	0.05	0.50		1.00	60	30	6.0			
SIR 5[1]	0.05	0.50		1.00	60	30	–			
SIR 10	0.10	0.75		1.00	50	30	–			
SIR 20	0.20	1.00		1.00	40	30	–			
SIR 50	0.50	1.50		1.00	30	30	–			
Test Methods	ISOR 249	ISOR 247		ISOR 248	BS 1673	ISOR 2007	RRIM			
MALAYSIA[2]										
SMR CV	0.03	0.50	0.60	0.80	60	–	–	Black	Transparent	Orange
SMR LV[3]	0.03	0.50	0.60	0.80	60	–	–	Black	Transparent	Magenta
SMR L	0.03	0.50	0.60	0.80	60	30	6.0	Light Green	Transparent	Transparent
SMR WF	0.03	0.50	0.60	0.80	60	30	–	Light Green	Transparent	Opaque White
SMR 5	0.05	0.60	0.60	0.80	60	30	–	Light Green	Transparent	Opaque White
SMR GP	0.10	0.75	0.60	0.80	50	–	–	Blue	Transparent	Opaque White
SMR 10	0.10	0.75	0.60	0.80	50	30	–	Brown	Transparent	Opaque White
SMR 20	0.20	1.00	0.60	0.80	40	30	–	Red	Transparent	Opaque White
SMR 50	0.50	1.50	0.60	0.80	30	30	–	Yellow	Transparent	Opaque White
SINGAPORE[2]										
SSR 5[1]	0.05	0.60	0.65	1.00	60	30				
SSR 10	0.10	0.75	0.65	1.00	50	30				
SSR 20	0.20	1.00	0.65	1.00	40	30				
SSR 50	0.50	1.50	0.65	1.00	30	30				
Test Methods										
THAILAND[2, 4]										
TTR 5L[1]	0.5	0.60	0.65	1.00	60	30	6.0	Light green	Transparent	Transparent
TTR 5[1]	0.5	0.60	0.65	1.00	60	30	–	Light green	Transparent	Opaque white
TTR 10	0.10	0.75	0.65	1.00	50	30	–	Brown	Transparent	Opaque white
TTR 20	0.20	1.00	0.65	1.00	40	30	–	Red	Transparent	Opaque white
TTR 50	0.50	1.50	0.65	1.00	30	30	–	Yellow	Transparent	Opaque white

[1] Derived from deliberately coagulated latex only

[2] For dirt content, figures pertain to dirt retained on 44μ aperture.

[3] Contains 4 p.h.r. light, non staining mineral oil. Additional producer control parameter acetone extract 6-8% by weight.

[4] For volatile matter, figures pertain to the consumer limit. The producer limit is 0.5%.

12. While the bulk of natural rubber is shipped as dry rubber, natural rubber latex represented in 1975 about 8.5 percent of total world exports.

13. Information on the exact breakdown of natural rubber consumption by grades is not available. In general, however, it appears that RSS 3, 4, 2, brown crepe and SMR/SIR 10 and 20 are the main grades used by tire manufacturers.

14. The development of synthetic materials with the same characteristics of resilience and elasticity as natural rubber has led to some confusion in terminology.

15. Synthetic rubber: Strictly speaking, there is no such thing as synthetic rubber. A number of synthetic compounds have rubber-like qualities, but they differ from each other and from natural rubber in many physical properties and in chemical composition. Thus while all natural rubbers have the same chemical composition and roughly the same physical qualities, there is a large and growing variety of synthetic rubbers. Although it is useful for some purposes to speak of synthetic rubbers it should be kept in mind that the reference is to a class composed of different types and kinds exhibiting different properties and derived by different manufacturing processes.

16. In the synthetic rubbers that have been produced commercially, the basic unit contributing elasticity bears little relationship to the (C_5H_8) unit of natural rubber either in composition or in structure. The monomer unit with the nearest structure to this is butadiene which has a chemical structure closely approximating that of isoprene (the monomer unit of the natural rubber molecule). Butadiene is basic to the synthesis of many of the synthetic rubbers but to give qualities similar to those of natural rubber, requires the use of a copolymer; consequently the structure of the resulting polymer is quite dissimilar to that of natural rubber.

17. In this handbook it is probably sufficient to note that there are three "general purpose" synthetic rubber types relevant to interaction with natural rubber: styrene-butadiene rubber (SBR), polybutadiene rubber (BR) and polyisoprene rubber (IR). The last of this is the chemical analogue of natural rubber and is therefore in theory, though not entirely in practice, 100 percent substitutable with natural rubber.

18. SBR is, in terms of tonnage, by far the single most important type of rubber in the world, Table I-A3. It represents about 38 percent of total elastomer consumption outside the centrally planned economies. Its share in total synthetic rubber consumption is even higher, about 58 percent. SBR has some important technical advantages over natural rubber but also some inferior properties. It has lower resilience and tensile strength but its resistance to mechanical, temperature, and environmental factors is roughly comparable to that of natural rubber. SBR, however, can be easily extended with oil, giving it good wear resistance and excellent grip. For this reason SBR is used mostly in automobile tire treads where good wear resistance and low propensity to skid on wet surfaces are necessary performance characteristics. Worldwide, more than 60 percent of all SBR is consumed in tires. Non-tire uses include footwear, conveyor belts, cable insulation, hoses, battery containers and adhesives. Physical properties alone, however, cannot explain the outstanding commercial success of SBR, its low production cost is also important.

19. BR is the second most important type of synthetic rubber and the third most important type of rubber in terms of volume: accounting in 1977 for 15.7 percent of synthetic rubbers outside the centrally planned economies and 10.3 percent of total elastomer (natural and synthetic rubbers) consumption. 1/ Because of its high resilience and low heat buildup, BR is used to improve the performance of SBR and natural rubber in tire treads, sidewalls and carcasses. BR is, therefore, almost exclusively a tire rubber and is hardly ever used alone.

1/ The term elastomer is used interchangeably with rubber in this handbook.

Table I-A3: WORLD ELASTOMER CONSUMPTION, BY KIND OF RUBBER, 1977

Kind of rubber	Thousands of metric tons	Percentage of synthetic rubber	Percentage of total rubber
Synthetic rubber			
Styrene-butadiene (SBR)	3,328	58.3	38.3
Polybutadiene (BR)	895	15.7	10.3
Polyisoprene (IR)	208	3.6	2.4
Ethlyene-propylene (EPM-EPDM)	290	5.1	3.3
Polychloroprene (CR)	318	5.6	3.7
Butyl (IIR)	386	6.8	4.4
Nitrile (NBR)	190	3.3	2.2
Other synthetic	91	1.6	1.1
Total	5,706	100.0	65.7
Natural rubber	2,984	-	34.3
Total elastomers	8,690	-	100.0

Note: Excluding centrally planned economies.

\- Not applicable.

Sources: International Institute of Synthetic Rubber Producers (IISRP), private communication; and International Rubber Study Group, Statistical Bulletin.

20. IR is the closest synthetic approximation of natural rubber. On the basis of its physical and processing characteristics it has found uses in areas where natural rubber was previously chosen, such as car, truck and bus tires, pharmaceutical and mechanical goods. Despite its excellent properties and high expectation of manufacturers in its market potential, IR has found it difficult to compete with natural rubber on a relative price basis. IR is still a costly synthetic rubber to produce, since both the derivation of the isoprene monomer and the polymerization process are technically more complex and costly than those of SBR. The market penetration of IR has been slow over the past ten years. In 1977, IR accounted for only 3.6 percent of all synthetic rubbers and 2.4 percent of all elastomers consumed outside the centrally planned economies.

21. The fundamental characteristic of all rubbers, whether natural or synthetic, is their elasticity. This is a unique ability to extend highly and retract forcibly at normal temperatures.

22. Another quality characteristic of rubbers is plasticity which enables them to be formed into usable shapes. Vulcanization is the chemical process that transforms the plastic (raw) condition into the elastic (finished) condition. These two conditions are not mutually exclusive, as there is considerable elasticity in the raw state of rubber and considerable plastic flow in the finished condition. However, the plastic condition must be of such character before vulcanization that the rubber can be molded, extruded or otherwise shaped. After vulcanization, the rubber must resist further change in shape and exhibit only a minimum yield to permanent deformation.

B. Economic

23. The practical importance of rubber is due to its physical properties such as softness, toughness, elasticity, impermeability, adhesion, and electrical resistance.

24. Rubber is used in approximately 2,500 products. The enormous array of rubber products does not permit easy classification. Very few countries break down their rubber consumption into useful categories and fewer still disclose the type of rubber used in each.

25. On a world basis, the breakdown of rubber consumption into main uses is not known with precision. The only estimated breakdown is between tire and non-tire uses, each accounting for about 50 percent of the total. The percentage share of rubber going into tires is higher in industrialized countries (where it accounts for about 57 percent of the total) than in developing countries and centrally planned economies (where tire rubber accounts, respectively, for 38 and 27 percent of the total). Closely reflecting the degree of motorization, the share of rubber tires in total rubber consumption ranges from 64 percent in the US to about 10 percent in the People's Republic of China.

26. In industrialized countries, the end-uses of rubber are known in much greater detail, even though category classificiations are often different between countries. Comparisons are often difficult especially for uses other than tires.

27. A comparison of the situation in the US, EEC and Japan revealed that tire uses are prevalent in all three areas, but substantial intra-area differences exist in the pattern of tire-rubber utilization, Table I-B1. Rubber use in passenger-car tires is relatively higher in the US than in Europe or Japan because of the higher levels of per capita automobile ownership and use as well as by the relatively larger average size of automobiles (and thus tires) in the US. After car tires, the largest single market for rubber is tires for commercial vehicle tires, such as trucks and buses. Japan uses more rubber for commercial vehicles, such as trucks and buses. Japan however, many commercial vehicles are small buses and small and midget trucks. Although their tires are categorized as commercial vehicle tires they are relatively more similar to passenger-car tires. After tires, latex products, footwear, belts and hoses, and wire cables are the most important uses for rubber.

28. Commercial vehicle tires represent the largest single outlet for natural rubber in the US, EEC and Japan, followed by passenger-car tires, Table I-B2. Commercial vehicle tires generally require more natural rubber

Table I-B1: ELASTOMER CONSUMPTION IN INDUSTRIALIZED COUNTRIES, BY MAJOR USES, 1970

Use	United States		European Economic Community		Japan	
	Thousands of metric tons	Percent	Thousands of metric tons	Percent	Thousands of metric tons	Percent
Tire						
Passenger car	855	34.0	420	22.6	110	14.1
Truck/bus	445	17.7	325	17.5	192	24.6
Tractor/industrial	100	4.0	75	4.0	21	2.7
Bicycle/motorcycle	3	0.01	25	1.4	13	1.7
Aircraft	9	0.04	3	0.02	0.3	-
Retreading	130	5.1	75	4.0	10	1.3
Inner tubes	45	1.8	50	2.7	39	5.0
Other products	20	0.07	20	1.1	15	1.9
Total	1,607	63.8	993	53.4	400	51.3
Nontire						
Latex products	203	8.1	195	10.5	74	9.5
Belting	30	1.2	40	2.2	43	5.5
Hose	50	2.0	45	2.4	15	1.9
Footwear	90	3.6	75	4.0	68	8.7
Wire and cable	30	1.2	40	2.2	12	1.6
Other products	507	20.1	471	25.3	167	21.5
Total	910	36.2	866	46.6	379	48.7
Total Consumption	2,517	100.0	1,859	100.0	779	100.0

Sources: Industry sources (interview data): International Rubber Study Group, Statistical Bulletin, various issues; and Malaysian Rubber Research and Development Board, The Techno-Economic Potential of Natural Rubber, MRRDB Monograph 1 (Kuala Lumpur: MRRDB, 1974).

Table I-B2: NATURAL RUBBER CONSUMPTION IN INDUSTRIALIZED COUNTRIES, BY MAJOR USES, AND NATURAL RUBBER SHARE IN EACH USE, 1970

Use	United States			European Economic Community			Japan		
	Thousands of metric tons	Share of total (percent)	NR share (percent)	Thousands of metric tons	Share of total (percent)	NR share (percent)	Thousands of metric tons	Share of total (percent)	NR share (percent)
Tire	400	70.4	24.9	384	54.8	39.0	154	54.4	38.5
Passenger car	124	21.8	14.5	110	15.7	26.0	31	11.0	27.0
Truck/bus	222	39.1	50.0	190	27.1	58.0	90	31.8	45.0
Tractor/industrial	30	5.3	30.0	45	6.4	60.0	10	3.5	45.0
Bicycle/motorcycle	...	-	-	7	1.0	30.0	8	2.8	60.0
Aircraft	8	1.4	90.0	3	0.04	90.0	0.3	...	100.0
Retreading	13	2.3	10.0	25	3.6	33.0	5	1.8	55.0
Inner tubes	2	0.03	5.0	2	0.03	5.0	4	1.4	10.0
Other products	1	0.02	5.0	2	0.03	10.0	6	2.1	04.0
Nontire	168	29.6	19.0	317	45.2	36.6	129	45.6	34.0
Latex produces	67	11.8	33.0	65	9.3	33.0	21	7.4	28.0
Belting	12	2.1	15.0	12	1.7	30.0	22	7.8	51.0
Hose	...	-	-	11	1.6	5.0	6	2.1	40.0
Footwear	22	3.9	25.0	26	3.7	35.0	30	10.6	44.0
Wire and cable	1	0.01	3.0	6	0.09	15.0	4	1.4	33.0
Other products	66	11.6	13.0	197	28.1	42.0	46	16.3	27.5
Total consumption	568	100.0	22.6	701	100.0	37.7	283	100.0	36.0

- Not applicable
... Zero or negligible

Sources: Industry sources (interview data); and MRRDB, The Techno-Economic Potential of Natural Rubber.

in the blend. The larger the tire, the greater the natural rubber share, since high wear-and-tear and cracking as well as low heat build-up are needed. Natural rubber has high resilience and, therefore, minimum heat build-up. Giant tires are made almost entirely of natural rubber (about 95 percent), large truck tires usually contain about 65 percent natural rubber, and small truck tires have only from 17 to 25 percent natural rubber. The relatively greater importance of small and midget trucks in Japan partially explains the lower share of natural rubber in commercial vehicle tires in that country.

29. Passenger-car tires are the second largest market for natural rubber, despite the heavy losses in market share suffered by natural rubber in the 1950s and 1960s. Comparison of natural rubber consumption shares in passenger-car tires shows an interesting difference between the US and Europe. The share of natural rubber is much higher in the EEC than in the US, largely because of the higher percentage of radial tires on passenger cars there. Radial tires, which require more natural rubber, gained consumer acceptance much earlier in Western Europe than in the US, where the industry went from cross-ply to bias-belted tires before getting into radial-tire production. Radial tires for passenger cars were introduced on a large scale in the US market only in the early 1970s. The situation in Japan is more similar to that in the US than in Europe. Radial tires were introduced in Japan in the late 1960s and early 1970s and, therfore, the share of natural rubber in passenger-car tires is lower than in Europe.

30. The third largest non-tire usage is in latex products where its market share is about 30 percent. Industrial tires, footwear, hoses, and belting are other important markets. An extreme illustration of the importance of technical and performance requirements that constrain the choice of rubber inputs is the market for aircraft tires, in which natural rubber has an absolutely predominant share. It is the only material that has the strength at very high temperatures and the resistance to fatigue during repeated flexing that are necessary in aircraft tires.

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II. THE LOCATION OF THE INDUSTRY

A. Production

Natural Rubber: The selection of areas suitable for growing and production of natural rubber depends on three main factors: climate, soil and available labor.

2. The climatic requirements for the cultivation of *Hevea* are geographically restricted to a belt extending some 20° to 25° north and south of the equator. However, only a small proportion of the land areas included in this broad belt is suitable for rubber cultivation - because of local variations in soil, climate, availability of labor and transportation facilities.

3. In general, except for local areas where weather conditions are extremely favorable, temperature restricts the cultivation of *Hevea* to a band less than half the width indicated above and, within this smaller belt, also eliminates desert areas where temperatures are excessive and elevated areas where temperatures are too low or slopes too steep.

4. *Hevea* requires at least 75 to 80 inches of rainfall annually, preferably distributed uniformly over the year. Good drainage is essential if the rainfall is higher.

5. For best growth the area selected should not have a distinct dry period; but there are exceptions such as in Vietnam, where a distinct dry season may last for as long as four months.

6. Diurnal variations in rainfall may be as important in rubber cultivation as seasonal variations. Rain at tapping time in the early morning interferes not only with the physical process of tapping but may cause the tapping channels and the latex cups to overflow, with consequent loss of crop.

7. *Hevea* has a wide tolerance to different soil types. As it is a tree crop, the workability of the soil is of less permanent importance than moisture absorption, moisture-holding capacity, drainage, resistance to flooding, and other factors of soil-moisture relationship. A deep soil is needed

to encourage deep penetration of roots. Surface rooting, resulting from shallow soils or bad surface drainage is a major factor in wind damage.

8. Rubber growirg and exploitation is labor-intensive, although labor-saving devices are becoming increasingly important in countries where there is a shortage of labor.

9. Apart from these three main factors, disease is also an important constraint on rubber production, at least in South America. The South American Leaf Blight which is a wind-borne fungal disease is endemic in South America. The ravages of the blight have prevented the establishment of a large-scale plantation industry there.

10. For these reasons production of natural rubber is concentrated in a relatively few countries. The main producing countries are in South and Southeast Asia. Of these, Malaysia, Indonesia and Thailand account for over 80 percent of total world natural rubber production, Table II-A1. Two other Asian producers, Sri Lanka and India, and two African producers, Liberia and Nigeria, together account for another 12 percent of total production.

11. World production of natural rubber which more than doubled between 1946 and 1950 grew at a more modest rate of slightly more than 3 percent per annum for the next 20 years. The interwar years left the natural rubber industry with a production growth potential that was well below market requirements. The very rapid expansion of motorization in Western Europe and Japan, as well as its spread to practically all areas of the world in the 1950s and 1960s, created a demand growth for elastomers that natural rubber was unable to meet. World elastomer demand increased at more than 9 percent per annum, while natural rubber production grew at less than 3 percent per annum over the same period (1948 to 1973). The slack was taken up by the synthetic rubber industry which after some initial adjustment difficulties experienced in the immediate postwar period, expanded very rapidly from 1949 onwards and continued to grow at about 9 percent per annum until the early 1970s.

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Table II-A1: NATURAL RUBBER - PRODUCTION BY MAIN COUNTRIES AND ECONOMIC REGIONS

	Actual							Estimated
	1960	1965	1970	1975	1977	1978	1979	1980
	('000 tons)							
Developing Countries	1,998	2,352	2,944	3,272	3,562	3,660	3,716	3,714
Malaysia	765	917	1,269	1,459	1,613	1,607	1,600	1,590
Indonesia	620	716	815	823	835	900	905	955
Thailand	171	216	287	355	431	467	531	518
Sri Lanka	99	118	159	149	146	156	153	141
India	25	49	90	136	152	133	147	150
Others	318	336	324	350	385	397	380	360
Centrally Planned Economies	-	-	-	23	30	35	98	100
China, People's Republic	-	-	-	23	30	35	98	100
WORLD TOTAL /a	2,035	2,352	3,102	3,315	3,605	3,715	3,855	3,790

/a For the years 1960, 1970, 1977, 1978, 1979 and 1980 the world total is not the sum of the two sub-totals. The differences are the statistical discrepancies shown in IRSG data.

Source: International Rubber Study Group (actual);
World Bank, Economic Analysis and Projections Department (projected).

12. Synthetic rubber: Synthetic rubber production spread quickly from the US and Canada to Western Europe and Japan. Western Europe began to produce synthetic rubbers on a large scale in the early 1960s, while Japanese production began on a significant scale in the mid-1960s. Developing countries did not produce synthetic rubbers until the late 1960s. Among the developing countries, Brazil and India were the first to establish their own synthetic rubber industries; they were followed by Argentina, Mexico, the Republic of Korea and Taiwan. Developing countries still accounted for only about 6 percent of world synthetic rubber production in 1979.

13. Natural rubber production outside the centrally planned economies is estimated at about 3.7 million tons in 1980, while the total demand for elastomers is expected to be around 9.5 million tons. Thus, if the balance of the demand for elastomers (outside the centrally planned economies) projected for 1980 were to be met by synthetic rubbers, the synthetic rubber industry would have to operate at about 90 percent of its projected capacity, compared with an historical average rate of 75-80 percent.

B. Consumption

14. The growth path of world rubber demand was shaped to a large extent by the growth of demand in automotive and other industrial uses in the industrialized countries where rubber utilization during the past 30 years grew at about 6 percent per annum. Rubber demand grew at even faster rates in centrally planned economies and developing countries - at 7 and 10 percent per annum, respectively - but from a much smaller initial base. Industrialized countries in 1979 accounted for 59 percent of total world elastomer consumption, centrally planned countries for 26 percent,and developing countries for the remaining 15 percent, Table II-B1.

15. Within the industrialized countries, the use of rubber increased faster in Japan and Western Europe than in North America, closely reflecting the differential rates at which motorization proceeded in these regions. During the past 30 years, motorization advanced more rapidly in Japan and Western Europe than in North America, where the process had started much earlier and

Table II-B1: CONSUMPTION OF NATURAL RUBBER AND TOTAL ELASTOMERS, BY MAIN ECONOMIC REGIONS

	Actual						
	1960	1965	1970	1975	1977	1978	1979
	('000 tons)						
Natural Rubber							
Industrialized Countries	1,406	1,546	1,845	1,981	2,189	2,118	2,166
Developing Countries	261	337	483	687	816	887	919
Centrally Planned Economies	448	565	665	700	705	720	785
WORLD TOTAL	2,115	2,448	2,993	3,368	3,710	3,725	3,870
Total Elastomers							
Industrialized Countries	3,100	4,269	5,924	6,370	7,505	7,403	7,545
Developing Countries	354	559	893	1,316	1,619	1,759	1,882
Centrally Planned Economies	980	1,345	1,785	2,755	3,025	3,235	3,365
WORLD TOTAL	4,462	6,188	8,615	10,395	12,160	12,415	12,920
NR Share of World Consumption of all Rubbers (%)	47.4	39.6	34.7	31.7	30.5	30.0	29.9
World excluding Centrally Planned Economies	47.9	38.9	34.1	32.9	32.8	32.7	32.2

Source: International Rubber Study Group, Rubber Statistical Bulletin (actual); World Bank, Economic Analysis and Projections Department (projected).

high levels had already been achieved by the end of World War II. In the centrally planned economies, rubber utilization increased ıster in Eastern Europe than in the USSR, although a reversal of this trend ııas become apparent in the past few years, following the decision of the USSR to increase automobile production for private use. Apparently, rubber consumption also increased quite rapidly in the People's Republic of China during the 1950s and 1960s, but the available data (which may not be reliable) show that both the aggregate and the per capita levels of rubber consumption are still rather low. Despite the uncertainty surrounding the available statistics, it is clear that both automotive and industrial utilization of rubber in China are strictly controlled by the government and kept to a minimum level to conserve foreign exchange.

16. Natural rubber is primarily consumed in industrialized countries, Table II-B1. In 1979 about 56 percent of all natural rubber was consumed in industrialized countries, 24 percent in developing countries and the remainder in centrally planned economies.

17. It will also be seen in Table II-B1 that the share of natural rubber in the total elastomer market (excluding centrally planned economies) has declined from about 48 percent to just over 32 percent. To prevent further erosion of its market share it is imperative that more natural rubber be produced.

C. Trade

18. Natural rubber is a typical export commodity: exports account for about 90 percent of world production. Domestic utilization of natural rubber in the main producing countries still represents a small, even if growing, percentage of total production: 8.5 percent in 1972-74 as compared with 2.5 percent in 1952-54. Synthetic rubbers, on the other hand are, for the most part, used in the producing countries: exports account for only about 25 percent of world production.

19. The major natural rubber producers: Malaysia, Indonesia, Thailand, are also the major exporters, Table II-C1. Malaysia accounts for 49 percent

Table II-C1: NATURAL RUBBER - WORLD EXPORTS, BY MAIN COUNTRIES AND ECONOMIC REGIONS

	Actual						
	1960	1965	1970	1975	1977	1978	1979
	('000 tons)						
Developing Countries	1,850	2,198	2,785	2,920	3,208	3,245	3,310
Malaysia	731	919	1,304	1,424	1,607	1,565	1,609
Indonesia	577	709	790	788	800	848	861
Thailand	167	211	279	335	404	442	518
Sri Lanka	105	124	154	161	135	138	128
Liberia	48	49	83	83	80	78	73
Others	225	186	175	147	182	174	161
WORLD TOTAL	1,850	2,198	2,785	2,920	3,208	3,245	3,310

Source: International Rubber Study Group (actual);
World Bank, Economic Analysis and Projections Department (projected).

Table II-C2: NATURAL RUBBER - WORLD IMPORTS, BY MAIN COUNTRIES AND ECONOMIC REGIONS

	Actual						
	1960	1965	1970	1975	1977	1978	1979
	('000 tons)						
Industrialized Countries	1,246	1,386	1,736	1,766	1,983	1,930	1,998
North America /a	440	461	596	704	874	820	831
Western Europe	589	670	804	707	752	693	744
Japan	173	207	292	299	305	367	376
Others	44	48	44	56	52	50	47
Developing Countries	204	263	370	507	611	631	682
of which:							
South Africa	19	29	32	39	38	42	42
Southern Europe	53	87	127	165	195	171	177
Centrally Planned Economies	430	543	709	707	661	624	650
Eastern Europe	144	155	205	232	215	175	185
USSR	173	248	317	235	198	225	215
China, People's Republic	113	140	182	240	247	220	250
WORLD TOTAL	1,880	2,192	2,815	2,980	3,255	3,185	3,330

/a United States and Canada only.

Source: International Rubber Study Group, Rubber Statistical Bulletin (actual);
World Bank, Economic Analysis and Projections Department (projected).

of total world exports, Indonesia for 27 percent, and Thailand for 12 percent. Natural rubber export trends in the postwar period have paralleled those of production. The producing countries of Asia continued to maintain their predominant position as the main source of natural rubber exports (94 percent of world total). The remainder continued to come from Africa.

20. Industrialized countries are still the main importers of natural rubber, but their import share has fallen substantially during the past 20 years: from 66 percent in 1960 to 58 percent in 1979, Table II-C2. This declining trend, however, appears to have levelled off in recent years, largely as a consequence of the increase in demand for natural rubber that resulted from the introduction of radial tires in North America and Japan. Developing countries, on the other hand, have continually increased their consumption of natural rubber: from 11 percent in 1960 to 20 percent in 1979. The share of centrally planned economies in total world imports of natural rubber doubled between the mid-1950s and the mid-1960s. The import growth rate has, however, slowed down considerably in recent years following the official move to produce more isoprenic synthetic rubber domestically.

21. World trade in synthetic rubbers is not only relatively small relative to production, it is also heavily concentrated in industrialized producing countries, Table II-C3. Industrialized countries account for 84 percent of world exports and 69 percent of world imports. Most of world trade in synthetic rubbers is among industrialized countries. The US, traditionally the largest single net exporter of synthetic rubbers, has in recent years been replaced by Japan. The EEC is also a net, although small, exporting area. Developing countries are the only net importing group. Centrally planned economies are largely self-sufficient in synthetic rubbers. The USSR and the German Democratic Republic, the two largest single producers, are also the main net exporters within the centrally planned economies. China is a small net importer of synthetic rubbers.

Table II-C3: WORLD SYNTHETIC RUBBER EXPORTS AND IMPORTS, BY MAIN COUNTRIES AND ECONOMIC REGIONS, 1955 TO 1977, SELECTED AVERAGES AND GROWTH RATES
(thousands of metric tons)

Economic region and country	1955-57		1966-68		1972-74		1975-77		Growth rate (anuual percentage)		
	Average	Percent-age of world total	Average	Percent-age of world total	Average	Percent-age of world total	Average	Percent-age of world total	1955-57 to 1966-68	1966-68 to 1972-74	1972-74 to 1975-77
Exports											
Developed countries	234.7	78.9	925.3	87.2	1,570.5	85.9	1,590.2	83.7	13.3	9.2	0.4
Western Europe	1.8	0.6	431.3	40.7	936.0	51.1	969.9	51.0	64.5	13.8	1.2
North America	232.9	78.3	424.8	40.0	374.6	20.6	343.1	18.1	5.6	-2.1	-2.9
Japan	...	-	65.2	6.1	254.1	13.9	273.0	14.4	-	25.4	2.4
Other	...	-	4.0	0.4	5.8	0.3	4.2	0.2	-	6.4	-10.2
Developing countries	...	-	9.0	0.9	43.5	2.3	33.5	1.7	-	30.0	-8.3
Centrally planned economies	62.9	21.1	126.7	11.9	215.1	11.8	277.1	14.6	6.6	9.2	8.8
Eastern Europe	40.4	13.6	74.3	7.0	128.2	7.0	151.6	8.0	5.7	9.5	5.7
U.S.S.R.	22.5	7.5	52.4	4.9	86.9	4.8	125.5	6.6	8.0	8.8	13.0
World total	297.6	100.0	1,061.0	100.0	1,829.1	100.0	1,900.8	100.0	12.3	9.5	1.3
Imports											
Developed countries	198.3	67.7	761.1	73.3	1,347.2	73.6	1,328.1	69.3	13.0	10.0	-0.5
Western Europe	151.9	51.8	584.4	56.3	1,053.8	57.6	1,034.9	54.7	13.0	10.3	-0.6
North America	15.5	5.3	91.4	8.8	205.3	11.2	211.3	11.2	17.5	14.4	1.0
Japan	9.6	3.3	52.4	5.0	25.5	1.4	21.9	1.2	16.7	-11.3	-4.9
Other	21.3	7.3	32.9	3.2	62.6	3.4	60.0	2.2	4.0	11.3	-1.4
Developing countries	23.1	7.9	142.3	13.7	301.1	16.5	322.5	17.1	18.0	13.3	2.3
Asia	3.6	1.2	29.7	2.9	100.5	5.5	122.8	6.5	21.1	22.0	6.2
Africa	1.0	0.4	24.4	2.3	77.5	4.2	85.1	4.5	33.7	21.0	3.2
Latin America	18.5	6.3	88.2	8.5	123.1	6.8	114.6	6.1	12.8	5.7	-2.4
Centrally planned economies	71.6	24.4	134.9	13.0	181.7	9.9	258.1	13.6	5.9	5.1	12.4
Eastern Europe	46.1	15.7	90.6	8.7	139.7	7.6	189.8	10.0	6.3	7.5	10.8
U.S.S.R.	25.5	8.7	34.7	3.4	27.2	1.5	57.1	3.0	2.8	-3.9	28.0
China	...	-	9.6	0.9	14.8	0.8	11.2	0.6	-	7.5	-8.8
World total	293.0	100.0	1,038.3	100.0	1,830.0	100.0	1,890.0	100.0	12.2	9.9	1.1

- Not applicable
... Zero or negligible

Sources: International Rubber Study Group, Statistical Bulletin, various issues; and OECD, Trade by Commodities: Exports, various issues.

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III. THE WORLD ELASTOMER INDUSTRY

A. Structure

The structure of the natural rubber industry is characterized by the large number of producing units. Despite its original commercial development as an estate crop, natural rubber soon proved to be an ideal smallholder crop. By the mid-1930s, available estimates of total area under rubber in the world indicate that it was evenly divided between estates and smallholdings. 1/ In terms of total rubber area, smallholdings are predominant today in all major Asian producing countries: they account for virtually 100 percent of the rubber area in Thailand, about 80 percent in Indonesia, 65 percent in Malaysia and 53 percent in Sri Lanka, Table III-A1. Taken together, smallholdings in these four countries constitute about 80 percent of the total rubber area.

2. In contrast, world production of synthetic rubbers (excluding specialty rubbers) is controlled by little more than 100 firms that operate about 300 plants.

B. Degree of Control and Integration

3. While practically all smallholdings are locally owned, foreign ownership of estates is still an important feature in some producing countries such as Malaysia and Liberia. In Malaysia, foreign interests, largely British, still own or control about 50 percent of the area under estate rubber. This is gradually changing, however, as a number of British-registered plantation companies have moved or are planning to move their domicile to Malaysia and to restructure their organization and equity to accommodate local participation.

4. In Thailand and Indonesia no foreigners are permitted to own land. The rubber industry in Thailand is wholly owned and controlled by local individuals

1/ Although a smallholding is generally taken to be less than 40 ha. each, this is officially true only in Malaysia and Thailand. As officially defined, a smallholding in Indonesia is less than 25 ha.; in India it is less than 20 ha., and in Sri Lanka it is less than 4 ha.

Table III-A1: STRUCTURE OF THE NATURAL RUBBER INDUSTRY, 1978

Country	Area			Production
	Estates 1/	Smallholdings 2/	Total	
	------------('000 ha)	------------		('000 tons)
Malaysia	640	1,360	2,000	1,606
Indonesia	455	1,875	2,330	880
Thailand	70	1,530	1,600	464
Sri Lanka	106	122	228	156
India	60	173	233	133
Philippines	19	n.a.	29	63
Liberia	77	43	120	78
Nigeria	32	218	250	53
Vietnam	100	-	100	40
Other	n.a.	n.a.	n.a.	212
Total	1,559	5,331	6,890	3,690

1/ Including government estates which are important in Indonesia, Sri Lanka and Vietnam

2/ Including holdings in land development schemes. Generally defined as individual holdings of less than 40 ha.

Source: International Rubber Study Group and World Bank.

or companies. In Indonesia the extent of foreign ownership, largely a legacy of the colonial era, is small. About 4 percent of the total area is still in the hands of a few large foreign-owned companies, notably Goodyear, Uniroyal, London Sumatra and Socfin. Government-owned estates, Perusahan Negara Pekebun (PNP), constituting about 10 percent of the total area, are estates that were expropriated from the Dutch after the country became independent.

5. The rubber industry in Sri Lanka has been restructed under the Land Reform Law of 1972, which was implemented in two stages. During the first stage, all locally owned land in excess of 20 hectares was taken over and placed in the hands of various government organizations. Under the second stage, implemented in 1974, all foreign-owned estates were nationalized and taken over by the State Plantation Corporation and Janawasana. In other words, the Sri Lankan rubber industry is now completely in local hands.

6. Unlike the synthetic rubber industry which is characterized by substantial forward and backward integration, there is minimal backward integration in natural rubber production. It was reported that some 4-5 percent of total natural rubber production is owned by the major US tire manufacturers.

C. Production and Trade Arrangements

7. To a large extent rubber production is conditioned by the type of source materials (latex and scrap) available, scale of operation and level of management expertise. The technology for producing latex concentrate is complex and capital intensive and, for this reason, latex concentrates are only produced by estates. Sheet making, on the other hand, is a relatively simple operation and one that a smallholder can easily learn to do. The conversion of latex and coagulum into technically specified or block rubbers is increasingly being undertaken by remilling factories and estates as well as by government-sponsored central factories.

8. By virtue of their larger scale of operation, marketing and management expertise, estates are better able to respond to market forces by varying their output mix.

9. The composition of rubber production and exports from the major producing countries is quite variable, with each specializing in certain types and/or grades. Malaysia specializes in the higher TSNR (technically specified natural rubber) grades and latex concentrates, Sri Lanka in pale and sole crepes, and Indonesia in the lower TSNR grades.

10. In general, the export trade of the major natural rubber producing countries is broadly based and the market outlets are well diversified. Within this general framework, however, a pattern of market specialization or concentration has developed. The special or close trading arrangements that evolved between producers and their traditional buyers can be attributed to historical, economic, geo-political, and other considerations. For example, the bulk of Malaysian rubber exports has traditionally gone to UK and the EEC, Indonesian rubber to the US, Thai rubber to Japan and Sri Lankan rubber to China, Table III-C1.

11. Consumers in the EEC are generally more quality conscious and it is logical that they should import more Malaysian rubber since Malaysia is the main producer of high quality dry rubber and centrifuged latex. This pattern has, in fact, been fostered and shaped by the trading activities of the foreign-owned, largely British, estates and trading houses over the years. American buyers, on the other hand, generally rely on SIR (Standard Indonesian Rubber) which is usually offered at a price discount to SMR (Standard Malaysian Rubber). In the case of Thai rubber exports to Japan, the trade balance in favor of Japan probably figures prominently in the overall trading policy. More specifically, Thailand is an important source of sheet rubber for which Japanese manufacturers apparently still have a strong preference. It is also reported that Thai rubber sheets are generally sold at a discount. Another factor to be mentioned is that the closer geographical proximity of Thailand to Japan means that the freight rates for Thai rubber exports to Japan are decidedly lower under the system of open rate in vogue than comparable rates for Malaysian rubber exports. Finally, the disproportionately large share of Sri Lankan rubber in the Chinese market has its origins in the rice for rubber barter agreements concluded by China and Sri Lanka in the early 1950s.

Table III-C1: NATURAL RUBBER EXPORTS BY MAJOR PRODUCING COUNTRIES, 1977

Importers	Exporters			
	Malaysia	Indonesia	Thailand	Sri Lanka
	(percentage)			
Singapore	23.6	41.7	13.9	-
USA	12.0	36.4	13.5	3.5
China	8.3	-	3.1	47.6
UK	6.0	0.9	-	3.6
Germany, Fed. Rep.	7.0	3.8	1.4	8.1
France	4.5	1.2	0.2	0.9
Italy	4.4	0.7	0.1	6.6
Spain	3.1	1.9	0.1	1.2
USSR	0.6	4.4	0.1	5.8
Japan	2.8	3.0	52.8	0.7
Others	21.7	6.0	14.8	21.6
Total	100.0	100.0	100.0	100.0

Source: International Rubber Study Group.

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IV. MARKET PARAMETERS

A. Supply Elasticities

All available statistical evidence on the short-run response of rubber production to price indicates that it is price inelastic (Chan, 1962; Wharton, 1963; Stern, 1965; Cheong, 1972; Chow, 1975; Grilli, et al., 1979). Table IV-A1 summarizes the supply price elasticities estimated at the means of production and prices for the major rubber producing countries. Estate rubber production is very price inelastic, Table IV-A2. Even allowing for a seven-year lag to alter capacity, supply seems to be quite price inelastic. The relatively long period required to change capacity and tree composition for any desired increase in production in response to higher prices will tend to make the long-run supply inelastic. Evidently, decisions to alter capacity with such a long-lived capital asset cannot be lightly made and the changes in productive capacity in any year are small relative to the total capacity. Further, the long-run adjustment by reducing capacity, i.e. going out of rubber altogether, faces difficulties since such a step often involves sizeable capital losses represented by the future income stream of the stand.

2. Although short-run adjustments to price by smallholders seem to be less rigid than estates, price responsiveness is still low (about 0.25). For reasons already given in respect of estates, the long-run supply response of smallholders can also be expected to be price inelastic.

Table IV-A1: NATURAL RUBBER SUPPLY PRICE ELASTICITIES

Country	Short-run Elasticity
Malaysia	0.19*
Indonesia	0.10*
Thailand	0.24*
Rest of the world	0.15*

*Significant at the 95 percent confidence level and above.
Source: Grilli, et al (1980).

Table IV-A2: MALAYSIAN ESTATE AND SMALLHOLDING SUPPLY PRICE ELASTICITIES

Sector	Elasticities Short-run	Long-run
1948-59 (Chan, 1962)		
All producers	0.12	
1945-68 (Cheong, 1972)		
Estates	0.05	0.08
Smallholdings	0.25	0.73
1954-61 (Wharton, 1963)		
All producers	0.08-0.15	
Estates	0.03-0.12	
Smallholdings	0.20-0.37	
1956-74 (Chow, 1975)		
All producers	0.15	
Estates	0.03	
Smallholdings	0.29	

3. The expected lack of long-run price responsiveness was supported by quantitative estimates made by Cheong (1972) who found long-run price elasticities of supply of 0.08 for estates and 0.73 for smallholdings, respectively. A more recent study by Behrman (1975) found no evidence that world long-run price elasticity was statistically significant.

4. A plausible explanation for the lack of differences between short-run and long-run price elasticities of supply may have to do with the use of quarterly or annual data of an aggregate type in studies of short-run response to price (Wharton, 1963). Such aggregate data in fact represent a mixture of both short- and long-run.

B. Demand Elasticities

5. Price elasticities: The demand for elastomers is a derived demand, with approximately 50 percent of all elastomers produced going into tires and another 15 percent going into non-tire and automotive products. The demand for tires is affected by the demand for automobiles, which in turn is influenced by the general level of economic activity. Since the price of tires is a small proportion of the price of automobiles, an increase in the price of elastomers has little effect on the price of its principal product. It can be expected, *a priori*, that the demand for natural rubber will be price inelastic, in the short-run, and that the level of industrial activity is the key factor in determining natural rubber demand.

6. The results of a number of studies indicated that the short-run price elasticity of world demand for natural rubber is highly inelastic and may not be significantly different from zero (Teken, 1971; Cheong, 1972; Reutens, 1971). Other studies reported estimates which while relatively small or inelastic, are nevertheless significant. Brown (1974) reported that using annual data, UNCTAD, in an unpublished 1968 study, estimated price elasticities of demand, presumably short-run, to be between -0.53 and -0.58. Later, on the basis of "empirical tests and inferential reasoning of other studies", he came up with a monthly demand elasticity of -0.2 (Brown, 1974).

7. Although Cheong (1972) found all price elasticities of world demand to be small and insignificant in the short-run, they amounted to roughly 0.2 in the long-run.

8. A major problem with many of the earlier studies was the fact that synthetic rubber prices were often left out as a variable from the demand equations, leading to misspecification problems. This important omission probably helps to explain why they almost invariably came up with the same answer, i.e. that both short- and long-run price elasticities of demand for rubber appear to be inelastic and largely invariant in size.

9. Market share elasticities: A recent study based on natural rubber market shares, which included synthetic rubber prices as a variable, found as expected, that short-run elasticities were smaller in absolute value than long-run elasticities (Grilli, et al, 1980). The values of the short-run market share elasticities summarized in Table IV-B1 appear reasonable and to conform with a priori expectation. The mean elasticity values range from 0.13 and 0.18 and are consistent with the notion that, in the short-run, a change in relative prices has only a small influence on the decision to choose one rubber input over another.

Table IV-B1: NATURAL RUBBER MARKET SHARE ELASTICITIES

Country/Region	Price Elasticity of Short-run 1/	Market Share Long-run 2/
North America	0.18*	0.36*
Western Europe	0.13*	0.46*
Japan	0.14*	0.25*
Other Industrialized Countries	0.005	0.17
Developing Countries	0.18*	0.31*

*Significant at the 95 percent confidence level or above.

1/ Estimated at the mean of the relevant variables.

2/ Obtained by dividing the short-run elasticity value by that of the adjustment coefficient.

Source: Grilli, et al (1980)

10. The values of the long-run market share elasticities are, however, questionable. While generally much higher than the short-run values and relatively larger for Western Europe than for North America and Japan - thus conforming to a priori notions - they are not as high as would have been expected. On a priori grounds one would expect long-run elasticities close to unity; instead the values obtained range only from 0.25 to 0.46. 1/

11. Since the market share elasticities and the price elasticities of demand are conceptually similar, one would expect the parameters of the short- and long-run price elasticities of demand to exhibit a similar order of magnitude as the market share elasticities.

12. Income elasticities: Traditionally, demand forecasts for elastomers have relied on the strong and stable statistical relationship existing between total elastomer consumption and GNP (or industrial production) growth in all major consuming areas. Coefficients of income elasticities of demand for rubber were computed on the basis of time series (or cross section) analysis and rubber demand was directly estimated using projections of future GNP growth.

13. The usefulness of this forecasting framework is now in doubt. Apart from problems of estimation, there are several other factors to be taken into account. First, the degree of motorization in most industrialized countries has reached a plateau; hereafter declining growth rates can be expected. Second, the intensity of motor vehicle use, particularly of private automobiles, can also be expected to grow more slowly than in the past both because of over-crowded roads and higher maintenance costs. Third, fuel conservation policies have ushered in a new breed of smaller, lighter and more fuel-efficient cars - leading to a reduction in rubber demand per vehicle, on the one hand, and better tire mileages, on the other. In view of these developments, it is probably necessary to scale down income elasticity coefficients for industrialized countries.

1/ In spite of attempts to find appropriate specifications for the market share equations and to minimize the serial problems implicit in the functional specification that was chosen, the confidence bands around the estimated long-run elasticities remained quite large.

14. While it would be theoretically preferable to estimate income elasticity coefficients in terms of per capita consumption and per capita income, this is difficult in practice because consumption statistics refer to direct domestic utilization of rubber in manufacturing and not the trade balances in finished rubber products. This makes it impossible to disaggregate "consumption" beyond broad economic regions (industrialized, developing and centrally planned) and prevents, in effect, the use of cross-section analysis of individual country data. Aggregation of (country) domestic utilization statistics by economic regions helps to deal with the problem of inter-regional trade in finished products (which is the largest portion of total trade) 1/ but does not overcome the difficulties caused by inter-regional trade. While the centrally planned economies are practically self-sufficient in rubber products, industrialized countries are net exporters of rubber products (especially tires) and developing countries net importers. The available statistics of total rubber utilization thus overstate the quantity of rubber actually consumed in industrialized countries and understate it in developing countries. 2/ The lack of uniformity and incompleteness of the available trade data series for rubber products makes it impossible to factor in trade balances and to arrive at reasonably accurate estimates of actual consumption even for broad groups of countries. 3/

1/ Because of the large inter-regional trade in rubber manufacturers, "per capita consumption data", derived by dividing direct domestic utilization of rubber by population, is virtually meaningless for most individual countries.

2/ Implicit in this is the consumption that rubber imports of developing countries have increased more rapidly than utilization.

3/ Trade in a number of rubber products is only recorded in value terms. When quantities are available (e.g. tires), the weights refer to the actual weight of the product and not to its rubber content. The country coverage also lacks uniformity.

15. Subject to thes qualifications, the historical income-elasticity coefficients of rubber demand estimated from time-series analysis of annual data range from 1.3 to 1.4 for the industrialized countries, 1.6 to 2.0 for the developing countries and 1.4 to 1.6 for the centrally planned economies (Grilli, et al, 1980).

C. Price Determination Mechanisms

16. The market for natural rubber being highly competitive, even small changes in the supply and demand balance are reflected in prices. The main factors that affect short-term natural rubber prices are changes in inventories and in inflation rates since both the demand and supply of natural rubber are quite insensitive to price changes.

17. In the longer term, however, natural rubber prices are largely determined by the trend in synthetic rubber prices. Synthetic rubber prices set the ceiling and floor (IR prices at the ceiling and SBR prices at the floor) within which natural rubber prices are expected to fluctuate.

18. Given the structure and pricing behavior of the synthetic rubber industry, the trend in synthetic rubber prices closely follows trends in the costs of the major petro-chemical feedstocks.

19. An engineering cost function developed in a 1978 World Bank study enabled crude oil prices and synthetic rubber prices to be related. This made it possible for crude oil prices and SBR costs to be linked in a systematic manner. It was estimated that in 1977 each additional dollar-per-barrel increase in the real price of crude oil adds 1.92¢/kg to the "low" SBR supply price and 2.80¢/kg to the "high" SBR supply price.

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V. MARKET PRICES

A. Natural Rubber

The marketing system for natural rubber is international in character involving as it does both primary and terminal markets. The established primary markets are in Singapore and Kuala Lumpur, while the major terminal markets are those of London, New York and Tokyo/Kobe. The location of these markets enables international trading to go on continuously around the clock. In addition, modern means of communication have enabled the linking of these markets into a cohesive marketing network. The open system of operation in these markets is so competitive and sensitive that the rubber market can be considered to approximate the textbook model of a perfect market.

2. Functionally, the rubber market can be divided into various sub-markets for different grades. Although the price of each grade is determined by the supply and demand for it, in practice they tend to move closely together, Table V-A1. This is due chiefly to the fact that they are interchangeable in end-use and, in part, to the activities of market speculators.

3. There are also sub-markets for various delivery positions or delivery months for the basic grade, RSS 1. The basis or price differentials between the current and forward months are a reflection of the additional costs (interest, insurance and warehousing) that have to be incurred in carrying stocks. Although the price differentials can widen or narrow from time to time, they tend, in the long run, to be closely interrelated because of the actions of hedgers and speculators.

4. Natural rubber prices in the post World War II period have fluctuated widely. However, four major peaks are easily identifiable: 1950-51, 1955, 1959-60 and 1973-74 when prices were substantially above trend levels, Figure V-1. The 1950-51 and 1973-74 peaks can largely be attributed to "exogenous" factors: the Korean war and the oil crisis, respectively. The 1955 and 1959-60 peaks, on the other hand, represent clearly the response of market forces

Table V-A1

NATURAL RUBBER PRICES (per metric ton)

	London (£ sterling)*					New York (U S dollars)			Kuala Lumpur (Ringgit)					S'pore (S'pore dollars)	
	R S S 1 (spot)	R S S 1 (c i f)	R S S 3 (c i f)	S M R 20 (c i f)	R S S 1 3 months forward†	R S S 1	R S S 3	R S S 1 3 months forward†	R S S 1	R S S 3 n	S M R. 5 L* (1 ton pallets)	S M R 10 (1 ton pallets)	S M R 20 (1 ton pallets)	R S S 1	R S S 1 3 months forward†
1969	231 0	222 3	219 9		228 0	577 5	568 0	563 1	1.539	1.512	..	...		1.539	1.538
1970	187 0	18? 4	175 1		191 9	462 5	454 1	467 3	1.244	1 193	..	...		1.244	1.276
1971	151 3	143 7	139 2		157 9	399 0	388 6	395 9	1.016	925	.	..		1.016	1,049
1972	148 9	147 7	141 9		155 7	402 1	381 8	398 1	935	881				935	959
1973	316 3	300 2	287 0n		318 1	785 1	753 4	759 6	1.655	1 567	1.680	1.587	1.580	1,667	1.666
1974	331 7	342 4	318 7	325 2	343 8†	868 0	803 6	849 9	1.794	1 605	1.886	1.612	1 600	1.820	1.807
1975	302 1	287 5	276 5	281 6	315 7	658 9	633 7	661 6	1.357	1 300	1.407	1.330	1 316	1.346	1.407
1976	484 9	475 0	460 2	465 4	507 6	872 3	837 6	878 4	1.991	1.897	2,132	1.910	1.898	1.931	1.973
1977	518 3	508 6	493 4	507 5	536 2	9?6 9	880 3	921 9	2.028	1.940	2.129	1.969	1.958	2.007	2 072
1978	543 7	552 7	540 4	536 5	555 2	1.108 1	1.072 6	1.106 9	2.300	2 225	2.341	2.166	2.156	2.256	2.287
1979 January	558 8	575 0	562 5	578 5	574 7	1.202 4	1.184 9	1 207 0	2.375	2.341	2.377*	2.322	2 322	2 336	2 363
February	609 4	608 4	595 9	601 9	625.9	1 273 6	1,245 8	1.275 9	2.504	2.456	2.482	2.416	2.416	2.465	2 501
March	594 4	608 9	597 2	602 5	610 7	1,388 9	1.351 2	1.336 6	2.567	2.521	2.571	2.490	2.488	2.539	2.547
April	605 1	640 8	628 3	640 2	624 1	1 473 5	1.434 1	1.402 7	2.793	2.722	2.814	2.681	2 667	2 772	2 710
May	615 5	665 8	653 3	658 8	633 0	1.444 5	1.405 2	1.435 8	2.926	2.833	3.004	2.814	2 786	2.911	2 820
June	644 3	684 9	672 4	667 5	658 6	1.496 3	1.455 6	1.499 1	3.043	2.947	3.233	2.897	2.872	3.045	2.973
July	586 8	638 5	625 8	634 2	610 0	1 467 3	1.434 3	1.479 9	2.919	2.825	3.204	2.812	2.792	2 919	2.924
August	572 4	625 0	612 5	624 0	587 5	1 430 4	1 397 5	1.449 5	2.848	2.759	3.150	2.727	2.711	2 843	2.845
September	597 4	635 1	622 5	616 5	616 8	1.442 0	1 397 9	1 449 5	2.816	2.720	3.095	2.649	2 636	2.810	2 862
October	612 4	650 4	637 6	627 6	633 1	1.497 2	1.453 1	1.493 6	2.853	2.751	3.082	2.651	2 639	2.851	2 942
November	638 1	662 5	648 9	627 8	657 6	1.465 0	1.420 9	1.468 8	2.895	2.784	3.052	2.641	2.631	2.897	2 941
December	660 3	668 4	652 6	662 2	676 9	1 498 1	1.454 0	1,512.9	2.954	2.849	3.084	2,673	2.663	2 953	3,023
Year	607 0	638 2	625 3	621 8	627 4	1,423 3	1.386 1	1,417.6	2,794	2,711	2,936	2,651	2 638	2 778	2.788
1980 January	744 3	732 2	713 2	680 5	762 2	1 664 5	1.613 4		3.329	3.175	3.437	2,963	2.953	3.312	3.396
February	792 7	794 8	745 1	740 5	827 4	1,833 4	1,742 8		3.692	3.417	3,781	3.175	3.165	3 625	3.824
March	684 5	709 6	659 9	670.0	705 4	1.645 1	1,578 7		3.279	3,087	3.579	2,910	2,894	3.242	3.388
April	647 5	688 6	658 1	640 8	671 5	1.576 6	1.501 8		3.225	3,081	3,509	2,936	2,904	3.195	3.273
May	591 1	630 8	605 5	604 4	610.1	1,510.7	1.455 1		2.933	2.845	3,256	2,780	2.741	2,878	2.977
June	589.6	623 5	604 3	601 0	612 0	1,497.3	1,464 2		2,948	2,864	3,133	2,719	2,684	2,915	2,973
July	571 7	615 0	598 9	573 5	595 0	1.491 4	1.458 3		2,901	2,824	2,861	2,642	2,621	2,858	2,911
August	600 7	631 4	615 0	578 8	626 8	1,525 9	1,491 8		3,003	2,920				2,969	3,033
September	636.1	650 2	629 9	585 8	656.1	1,667.6	1,608 8		3,096	2,989				3.068	3,169
October	611 6	630 2	609.2	542.5	636 5	1,768 0	1,701.4		3,029	[illegible]97					
November															
December															
Year															

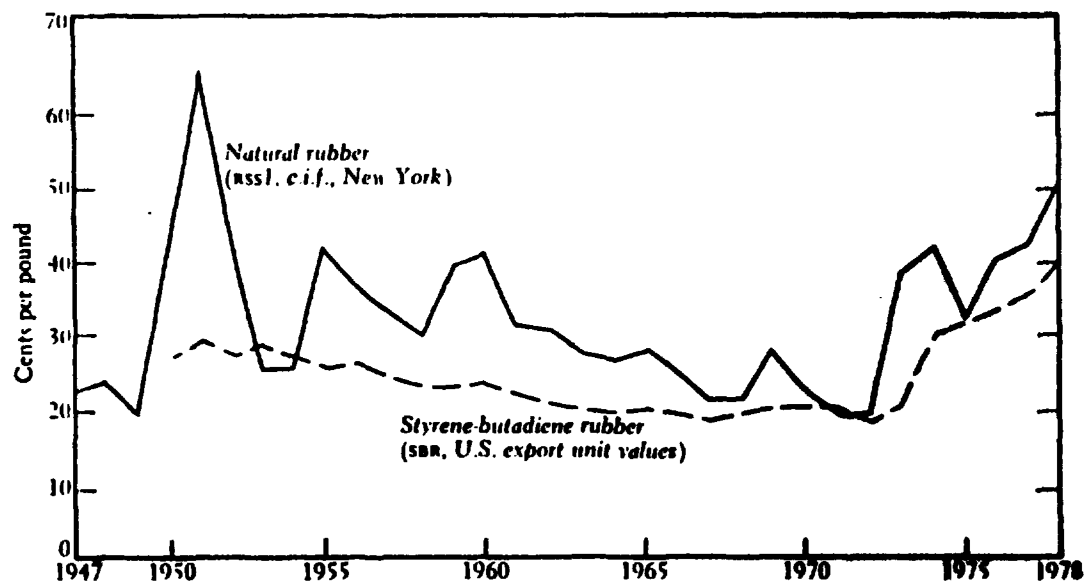
N B - New York quotations refer to sellers' asking prices for delivery during the current month, those for Kuala Lumpur and Singapore are buyers' midday prices f.o.b. in bales. London prices are buyers' prices except for S M R 20, which are sellers' prices. n - Nominal.

† - Since the introduction of the "Rubber Terminal Contract" in September 1974 forward prices in London are for two months ahead. Previously (in accordance with "Settlement Terms, Contract No. 7") they were, as is still the case in New York and Singapore, the quotations for three months forward excluding the current month.

* - Changed to SMR L from January 1979.

Source: International Rubber Study Group.

Figure V-1: PRICE TRENDS OF RUBBER, 1947 TO 1978



Source: Grilli, et al, The World Rubber Economy: Structure, Changes and Prospects, Baltimore Johns Hopkins Press, 1980.

to demand-boom conditions: world motor vehicle production increased by 34 percent in 1955, by 22 percent in 1959 and by 18 percent in 1960.

B. Synthetic Rubbers

5. From the early 1950s - when synthetic rubbers came to be produced in commercially large quantities - to the early 1970s, the trend in natural rubber prices was one of decline. The main cause was the steady fall in synthetic rubber prices resulting from economies of scale and technical progress in the world synthetic rubber industry. As synthetic rubbers became progressively more and more important in world elastomer markets, their prices began to set the overall trend, relegating natural rubber producers to the position of price takers.

6. The structure of the synthetic rubber industry is such that prices can be readily differentiated between markets - both regional and use-specific. For this reason, a "world price", even for a specific type of synthetic rubber, is almost impossible to reconstruct. The exception seems to be SBR for which the long-run trend in world prices is approximated reasonably well by the trend in US export unit values, Table V-B1. The available empirical evidence confirms the hypothesis that the declining trend in natural rubber prices from the early 1950s to the early 1970s was influenced by the decline in general purpose synthetic rubber prices.

7. A marked deviation in the natural rubber price trend took place in 1973-74 as a corollary of the oil crisis and the subsequent quadrupling of crude oil prices. As a result, both the short- and the long-run cost curves of the natural and synthetic rubber industries were affected, and the interaction between natural and synthetic rubber prices has now shifted to a different and higher trend level.

Table V-B1: SYNTHETIC RUBBER UNIT EXPORT VALUES IN THE UNITED STATES, 1960 TO 1980
(US cents per pound)

Year	SBR[a]	SBR[b]	BR	EPM-EPDM	IR	NBR	IIR
1960	31.0	21.5	38.3			46.5	23.0
1961	29.7	20.7	38.3			47.2	23.2
1962	26.0	19.4	35.9		25.7	45.5	22.5
1963	26.4	18.5	33.5		22.9	46.8	24.7
1964	24.5	17.9	29.9		22.9	44.6	25.8
1965	25.1	18.1	27.5		22.9	45.6	24.9
1966	24.5	17.5	25.1		23.8	44.9	25.6
1967	23.1	17.1	23.9		22.0	41.2	25.7
1968	24.2	17.3	21.6		21.1	39.2	25.7
1969	21.2	18.2	20.4		22.0	38.3	25.2
1970	19.7	17.8	18.7	32.8	19.4	37.8	25.6
1971	20.5	17.5	19.9	26.3	18.9	36.4	24.7
1972	17.9	17.5	19.7	28.6	20.2	37.1	24.3
1973	18.5	19.0	19.3	30.7	22.8	36.3	27.3
1974	28.5	27.4	32.6	35.3	37.8	42.3	30.7
1975	29.8	28.3	30.2	45.0	37.3	43.2	38.5
1976	31.0	30.7	32.0	59.7	48.4	44.6	42.6
1977	36.4	35.6	31.1	51.3	46.4	56.3	45.3
1978	37.7	37.3	39.8	56.5	50.4	62.0	47.1
1979	41.8	42.3	45.0	60.8	63.0	60.2	51.7

[a]Excluding latex

[b]Total SBR

Source: United States Department of Commerce, US Exports, Commodity by Country, Schedule B (after 1979 Schedule E), various issues.

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VI. SPECIAL ISSUES

A. Export Taxes

1. Export taxes on rubber have long been used in the producing countries as the principal instrument for generating public revenue. In view of the importance of such taxes on the government, producers and the rubber trade, the composition and structure of the taxes in the major producing countries are now briefly reviewed.

2. Malaysia: All grades of rubber exported from Malaysia are subject to a uniform three-part tax, comprising an export duty, a replanting cess and a research cess. The export duty is levied on a sliding scale above a gazetted price of M$1.10/kg. The gazetted price is determined by averaging the RSS 1 f.o.b. daily prices quoted by the Kuala Lumpur market over a four-week period preceding the week in question. The gazetted price and duty rate are revised every Thursday. The proceeds of the replanting cess, levied at 9.9¢/kg, go toward rubber replanting and modernization. While the cess collected from estates is automatically refunded, provided the rate of replanting has been satisfactorily maintained, smallholders receive the refund in the form of a replanting grant. Finally, a research cess of 2.2¢/kg is collected to finance rubber research and development.

3. The structure of the export duty on rubber with its relatively heavier burden on smallholders has had adverse impacts on the industry and trade. Furthermore, the relatively higher tax incidence on rubber, as compared, e.g. to oil palm, encouraged many estates to replant their rubber areas with oil palm. The Malaysian authorities are, however, aware of the problems that the tax inequities have created and steps have now been taken to rectify them.

4. Indonesia: In Indonesia, rubber exports are taxed at a uniform rate of 5 percent of "check prices" for different rubber grades. Check prices are determined each quarter, but are subject to revision in the event of

drastic changes in prices. Check prices each quarter are based mainly on daily prices in the New York market for the previous three months, although prices from Singapore and London are also used for comparison. The New York prices are then converted to their f.o.b. equivalents in terms of the rupiah. Unlike in Malaysia where a uniform duty rate calculated on the RSS 1 price was previously imposed, different duty rates are levied on different rubber grades in Indonesia. Also no other cesses are collected outside of the tax on rubber exports.

5. Thailand: Rubber exports from Thailand are subject to an export duty, a replanting cum-research cess and a revenue duty. The export duty is levied on a sliding scale according to the gazetted price, which is based on the previous month's daily prices of RSS 3 obtained from a combination of local and foreign markets. In comparison with other producing countries, the Thai system of gazetting an official price is the most elaborate. As in Indonesia, and now Malaysia, the duty is assessed for different types and grades of rubber. The replanting cess, based on 10 percent of the gazetted price, is used to finance grants for replanting, replanting administration and research in the ratio of 90:5:5. A rather unusual feature of the export tax is the imposition of a revenue tax of 0.05 baht/kg.

6. Sri Lanka: The export tax in Sri Lanka is unique, in that, in addition to an export duty, replanting and research cesses, a rubber control cess and a medical wants ordinance cess are also imposed. The export duty is levied on a sliding scale according to the gazetted price over and above an officially determined cost of production and profit margin. The gazetted price is based on the preceding week's average closing price of RSS 1 in London, with appropriate adjustments for freight and insurance to arrive at its local equivalent.

B. International Natural Rubber Agreement, 1979

7. The main objective of the Agreement is to stabilize conditions in the international natural rubber trade by avoiding excessive price fluctuations.

8. Natural rubber prices are to be stabilized through the operations of an international natural rubber buffer stock of 550,000 tons. This buffer stock will consist of a normal buffer stock of 400,000 tons and a contingency buffer stock of 150,000 tons.

9. For the operations of the buffer stock, the Agreement has established a price range consisting of a reference price or mid-point price, and three prices above and three prices below it. The price range that will apply on the entry into force of the Agreement has already been agreed. The reference price will initially be 210 Malaysian/Singapore cents per kilogram. The upper and lower intervention prices are calculated as plus or minus 15 percent of the reference price; initially, the upper intervention price will be 242 Malaysian/Singapore cents per kilogram and the lower intervention price will be 179 Malaysian/Singapore cents per kilogram. The upper and lower trigger action prices are calculated as plus and minus 20 percent of the reference price; initially, these prices have been set at 252 and 168 Malaysian/Singapore cents per kilogram, respectively. For the first 30 months after the entry into force of the Agreement, the upper and lower limits of the price range have been set at 270 and 150 Malaysian/Singapore cents per kilogram, respectively.

10. When the market indicator price is in the zone between the lower and upper intervention price, the Buffer Stock Manager will not intervene in the market. When the market indicator price 1/ is below the lower intervention

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1/ The daily market price is a composite, weighted average - reflecting the market in natural rubber - of daily official current-month prices on the Kuala Lumpur, London, New York and Singapore markets. Initially, the daily market indicator price will comprise RSS 1, RSS 3, and TSNR 20, weighted equally. All quotations are, then, converted into f.o.b. Malaysian/Singapore ports in Malaysian/Singapore currency.

price, the Buffer Stock Manager may buy rubber to defend the lower trigger action price. When the market indicator price is at or below the lower trigger action price, the Buffer Stock Manager must buy rubber to defend the lower trigger action price. Similarly, when the market indicator price is above the upper intervention price but below the upper trigger action price, the Buffer Stock Manager may sell rubber, but when the price is at or below the upper trigger action price he must sell rubber to defend the upper trigg action price.

11. When purchases or sales for the buffer stock reach the 400,000 ton level, the INRC (International Natural Rubber Council) staff shall meet and decide by special vote, on the price at which the contingency buffer stock is to be brought into action to defend the lower or upper indicative prices. Unless the Council decides otherwise, the contingency buffer stock will be brought into action at a point midway between the trigger action prices and the indicative prices.

12. The Agreement contains a provision for automatic revisions of the reference price. These revisions will be based on market trends and/or net changes in the buffer stock. In addition, the Council may, by special vote, review and revise the upper and lower indicative prices under the Agreement every 30 months after the entry into force of the Agreement. In exceptional circumstances, the Council may, at the request of a member or members holding 200 or more votes in the Council, review and revise the indicative prices.

13. Article 61 of the Agreement stipulates that it shall come into force definitively on October 1, 1980 or any date thereafter when governments accounting for at least 80 percent of net exports and 80 percent of net imports have deposited their instruments of ratification, acceptance, approval or accession, or have assumed full financial commitment to it. There shall be provisional entry into force on October 1, 1980 or any date within two years thereafter, when the proportionate adherence of exporting and importing governments is at least 65 percent in both cases.

14. The Agreement has come into provisional force and the first session of the International Natural Rubber Council was held in November, 1980 in Geneva. It was decided at the meeting that the headquarters of the International Natural Rubber Organization would be in Kuala Lumpur.

15. Although the Agreement has just come into provisional force, and natural rubber prices are well above the range set in the Agreement, it is unlikely to have any impact in the short-term.

C. Transportation of Natural Rubber

16. Ocean going merchant vessels can be broadly classified on the basis of commercial and technical features, e.g., liner vessels, tramps or bulk-carriers, tankers, and specialized vessels.

17. Liner vessels make regularly advertised and scheduled sailings on given routes, between specified ports. Tramps and bulk-carriers, on the other hand, sail between ports wherever and whenever cargo is available with no specific route determined in advance. Tankers sail between points of origin and the consumer markets, again with no predetermined schedule, whereas specialized vessels are built to meet the specialized requirements of the trade, e.g. LASH (Lighter Aboard Ship) 1/ and containerships. 2/

18. Liner vessels are most widely used in the natural rubber trade. A liner service can be provided by "conference" or "non-conference" carriers. A freight conference is a consortium of ship owners who have come together and pool their resources to operate rationalized liner services based on minimum rate structures for specified routes. Non-conference carriers are lines which do not belong to a conference and whose rates and operating procedures are independently established. Their sailing schedules are generally fewer and their destinations frequently limited to certain ports of discharge.

19. Freight conferences can be further distinguished between "open" or "closed" conferences. Open conferences have less power because of regulations and restrictions (such as those laid down by the US Federal Maritime Commission) requiring that membership of freight conferences be open to any shipping line offering regular liner service in the area of operation. Furthermore, they are prohibited from offering deferred rebates. Where special rates are offered to contract shippers, they cannot be more than 15 percent below the rates charged to non-contract shippers.

1/ LASH is a large mother ship holding many (as many as 89) small barges known as lighters. A lighter is a very large container capable of holding approximately 400 tons of cargo.

2/ Container shipping has not caught on because of the cost and logistics of containerization.

20. By far the most powerful freight conference plying between Europe and the Far East is a closed conference known as the Far Eastern Freight Conference (FEFC). It has 28 full member lines and 10 associated member lines. In 1978 about 75 percent of all Malaysian rubber exports was still transported on FEFC carriers.

21. The other shipping service of significance to the natural rubber trade is the bulk carrier service started in 1971 by the Natural Rubber Shippers Association (NRSA) of the US to ship dry rubber from Southeast Asian, particularly Indonesian, ports to US ports. NRSA is a non-profit association whose members comprise of natural rubber suppliers, dealers/ importers and US manufacturers. Its main objective is to obtain the most efficient and economic mode of transportation for its members. To that end NRSA encourages cargo consolidation and does not restrict its members from using outside carrier services. In fact, NRSA generally uses more than one ocean carrier, frequently using both chartered vessels and liner vessels from both conference and non-conference lines.

22. Freight Rates: The freight rate is the cost of carrying one unit (weight or volume) of a commodity, in this case rubber, between two sea ports. It is composed of many elements, some of which are fixed, such as insurance, crew, maintenance, depreciation, interest and administration. Others are variable, depending upon cargo carried, route or ports of call. A fair return on capital is, perhaps, the most difficult cost element to determine.

23. Freight rates are influenced by economic and political developments, as well as by the type of shipping service, the type of vessel used on the route, the physical quantity, and handling of the commodity. The average utilization of vessel capacity similarly affects freight rate levels in a given conference.

24. Ports of call are classified as (a) base ports, (b) optional ports, and (c) transshipment ports. Tariff rates are quoted as direct freight rates or transshipment rates (through local carrier) and extra charges are made for transshipment of cargo.

25. Tariff rates are discounted by 10 percent to contract shippers. There are also deferred rebates granted to shippers who are loyal to a conference and secret agreements with large volume shippers giving them special rebates/rates to retain their support. Table VI-C1 details freight rates (in Malaysian cents per kg) charged by the FEFC for the transportation of natural rubber from Malaysian ports to European ports.

26. In view of its virtual monopoly over the shipment of natural rubber from the Far East to Europe, the FEFC is able to impose increases in freight rates on rubber shippers. Taking the period 1971-77, there have been six annual increases in general freight rates amounting to 17.5, 8, 4, 18, 12 and 12.5 percent, respectively. After taking into account rebates and surcharges, the net rates to shippers still amounted to 8.7¢/kg in 1971, increasing to 18.1¢/kg in 1977. Table VI-C1 also shows that the freight rate in 1977, as a percentage of the RSS 1 price, was 9.4 percent. Non-conference rates are generally pegged to FEFC rates at discounts ranging from 25-35 percent.

27. By using a combination of chartered and liner vessels from conference and non-conference lines, the NRSA is able to obtain for its members freight rates to North American ports which are between 10-15 percent below normal.

Table VI-C1: FAR EASTERN FREIGHT CONFERENCE RATES TO UK/EUROPE DESTINATIONS, 1971-77

Effective date	Net Freight in M¢/kg	Average RSS 1 (f.o.b) price in M¢/kg	Freight rate as % of RSS 1 f.o.b. price
2/1/71	8.66	102.4	8.5
2/12/72	9.78	88.7	11.0
8/21/72	11.62	89.4	13.0
9/1/73	11.25	169.8	6.6
3/1/74	13.81	226.5	6.1
1/1/75	16.24	127.8	12.7
3/15/76	16.54	191.8	8.6
7/1/77	18.06	192.8	9.4

Source: Ng, et al., 1979

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