The World Rubber Industry

Despite the fact that rubber is one of the world's major commodities, surprisingly little has been written about the subject. First published in 1994, The World Rubber Industry seeks to redress this deficiency. It presents information in a clear and accessible manner, with numerous tables and illustrations, and an extensive glossary. This is a comprehensive and definitive analysis of one of the world's major and most essential commodities.
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The World Rubber Industry

Colin Barlow,
Sisira Jayasuriya,
and
C. Suan Tan
Rubber is one of the world’s major commodities. Its changing patterns of production, ownership and trade reflects major features of industrial organization and economic integration in the evolving global economy. Yet, despite the global importance of the industry, surprisingly little has been written about it in recent years.

The World Rubber Industry redresses this deficiency and brings the study up to date. The authors present a thorough analysis of the industry covering the production and processing of synthetic and natural rubber and their manufacture into rubber goods. They look first at the history, development and present situation of the two types of rubber in countries around the world, exploring the technologies and institutions involved and reviewing economic, social and political influences. They also scrutinize the history and development of rubber manufacturing, and the patterns of rubber consumption, marketing and trade which this sustains. Finally, they address some central features arising from the analyses and discuss future prospects.

Information is clearly presented and accessible with numerous tables and illustrations. The work likewise includes an extensive glossary for those unfamiliar with the terminology. The World Rubber Industry presents a comprehensive and definitive analysis of one of the world’s major and most essential commodities.

Colin Barlow is a Senior Fellow in Economics at the Research School of Asian and Pacific Studies, Australian National University. Sisira Jayasuriya is a Reader in Economics at La Trobe University, Australia. C. Suan Tan is Director of Advanced Strategies Consultancy Ltd, Hong Kong. All three have extensive research experience in the sphere of rubber. Their combined areas of interest are complementary and give the book greater depth.
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THE WORLD RUBBER INDUSTRY

Colin Barlow, Sisira Jayasuriya and C. Suan Tan

Routledge
London and New York
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This book is about the production and marketing of synthetic and natural rubbers, and their consumption in rubber products. It treats these activities in a global context, especially reviewing the economics of the operations involved.

Dealing adequately with this topic is a big task, particularly as the goal has been to produce an empirically accurate study of a huge and diverse industry. Thus, before the book could be written much 'fieldwork' had to be done around the world, in places ranging from synthetic rubber plants in North America to natural rubber smallholdings in Indonesia and rubber goods factories in Western Europe. Agents engaged in trading rubber also had to be interviewed. After these fact-finding efforts the various analyses had to be drawn together, and the book written.

Fortunately some parts of the industry are well documented, and the numerous publications and reports consulted are detailed in the list of references. But problems arise here from the fact that excellent studies are often in languages which many readers will not comprehend. Most quoted publications are accordingly in English, although some papers in Indonesian and French are also included. A glossary of non-English words, and of acronyms, technical items, definitions, and uncommon terms is included to assist readers.

To facilitate international comparison the metric system is employed in all measurements, and the United States dollar in all valuations. The latter are made at concurrent exchange rates with currencies of other countries, and these are listed for the years 1950–91 in the Appendix (see Table A.1). ‘Present day’ values are expressed in US dollars of 1991.

The authors' institutions of employment played crucial roles in supporting them during their work on the book. Much the most major help came from the Department of Economics, Research School of Pacific Studies, Australian National University, Canberra, which provided a salary, other resources, and frequent opportunities for consultation to the senior author, Dr C. Barlow, during his four years on the study. Wolfson College, Oxford also supplied Dr Barlow with facilities over a 6-month sabbatical in 1990.
The Department of Economics, La Trobe University, Melbourne likewise supported Dr S.K.W. Jayasuriya during his work on the book, and the World Bank gave Dr C.S. Tan leave of absence for her participation. These institutional contributions are all most gratefully acknowledged.

Other institutions aiding the authors are quoted in the Bibliography, but further special appreciation is expressed to the International Rubber Study Group, London, which was generous in contributing background publications and other facilities as the work proceeded.

Many individuals have helped the authors in researching the book, and a few people have declined special mention, however, although their names are included amongst those listed below. The authors would like to pay tribute to the generous assistance of the following:

For comments and advice on particular aspects of the study – Dr P.W. Allen, Mr A.G. Altenau, Mr R.L. Armbruster, Dr Aziz bin Abdul Kadir, Dr C.S.L. Baker, Dr P. Basuki, Mr D.A. Bennett, Mr P. Bierrie, Mr Ron Billet, Mrs M. Bleuer, Mr S.W. Bois, Mr Peter Boorman, Mr D.J. Boumans, Dr S. Budiman, Dr Kees Burger, Mr F.W. Campbell, Mr J. Carr, Mr Bruce Carrad, Mr G.P. Cavallini, Mr Philip Chalmin, Mr J. Chaudron, Mr W.B. Chodziesner, Mr J.D. Clark, Dr Ridwan Dereinda, Professor R. Duncan, Mr F.J. Eaton, Dr A. Edelenyi, Mr P. Erdos, Dr D. Etherington, Mr D.J. Finley, Mr P. Flothow, Mr K. Freise, Professor Ross Garnaut, Mr Philip Gatland, Dr Tharian George, Mr G. Giuliani, Ms Anne Gouyon, Mr K. Greene, Mr W. Gunter, Dr Habibah binte Suleiman, Dr H. Hill, Dr L. Horatz, Mr P.E. Hurley, Mr K.P. Jones, Mr R.L. Jones, Dr Prachaya Jumpsat, Professor F.N. Kelley, Ms Alison Kirk, Ir D.C.M. Kleverlaan, Dr P. Knappertsbusch, Mr M. Koniger, Mr Somporn Krisanasap, Mr James Le Blanc, Mr S.G. Leitch, Dr Lim Sow Ching, Mr J.C. Marques Pereira, Mr Soltan Mawardi, Mr F. Mersch, Mr D. Meyer, Mr L.J. Muenzen, Dr Mukhalis bin Baba, Dr A.P. Nikandrov, Mr Edgar Nordmann, the late Dr O.S. Peries, Professor George Peters, Mr A.G. Petrin, Mr J.S. Powath, Mr A. Propper, Dr Jaime Quizon, Mr F.J. Raniolo, Mr J.M. Riley, Mr P. Rowley, Mr B. Rosenbaum, Tan Sri Dr B.C. Sekhar, Mr J.S.C Shepherd, the late Mr H. Shimada, Mr Sjamsudin bin Tugiman, Dr Hidde Smit, the late Dr Carl Snyder, Dr Sundrum, Dr P.O. Thomas, Ir. L. Toniutti, Mr A. Verschave, Dr F.K. Von Herz, Mr J.P. Vuillerme, Mr H. Walsh, Mr J.N. Walsh, Professor Peter Warr, Mr Philip Watson, Mr R.J. Wesley, Mr K.I. Wylie, Dr Charles Young, Mr Zahari Zen. Thanks are also expressed to numerous farmers and factory workers, who likewise provided much information. None of these persons, however, necessarily endorsed any of the ideas or arguments presented in the book.

For sustained and imaginative assistance in research – Ms C. Condie, Mr T. Gregan and Mrs S. Kapur.

For keyboard work – Mrs S. Bodger, Mrs J. Fernando, Mrs H. Heidemanns, Ms T. Joce, Mrs C. Kavanagh, Mrs A. Louttit.
PREFACE

For keyboard work and other major assistance in finally assembling the draft as a book – Mrs L. Cowley.

For cartographical work – Mr K. Mitchell.

The authors' greatest debt of all is to their families, which supported them loyally and wholeheartedly over the long years of preparing and writing the book.

Canberra, Australia

August, 1993

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August, 1993

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C.S. Tan
INTRODUCTION

Rubber is a key material in modern life. Its main application is in vehicle tyres, but it is also used in a vast array of other articles ranging from conveyor belts to examination gloves (Table 1.1). On average each global inhabitant in 1990 consumed 2.9 kg of rubber, although individual countries varied widely in this figure (Table 1.2). The total value of all rubber produced and consumed in 1992, which was a year of low prices, was some $20 billion. Thus rubber is one of the world's major industrial raw materials.

Rubber comes from two very different sources, one 'natural' and one 'synthetic'. Making natural rubber (abbreviated as NR) entails cultivating what was originally a tree of the Amazonian jungle, Hevea Brasiliensis. This has its bark 'tapped' through a long cut around its trunk. The white rubber liquid or 'latex' flowing from that cut is collected in a small cup, and processed into raw intermediate rubber for industrial use. Making synthetic rubber (SR) entails using an industrial process to convert monomers obtained from oil or natural gas into latex. This is again transformed into intermediate rubber.

While most Hevea trees are grown on tiny plots by smallholders in poorer countries, synthetic rubber is made in great factories which may themselves

<table>
<thead>
<tr>
<th>Table 1.1 Uses of rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellular and foam articles</td>
</tr>
<tr>
<td>(mattresses and padding)</td>
</tr>
<tr>
<td>Carpet underlays</td>
</tr>
<tr>
<td>Adhesives</td>
</tr>
<tr>
<td>Hot water bottles</td>
</tr>
<tr>
<td>Gumboots</td>
</tr>
<tr>
<td>Sheeting</td>
</tr>
<tr>
<td>Conveyor belts</td>
</tr>
<tr>
<td>Medical and industrial gloves</td>
</tr>
<tr>
<td>Diving suits</td>
</tr>
<tr>
<td>Hoses</td>
</tr>
<tr>
<td>Shoes</td>
</tr>
<tr>
<td>Walksurfaces</td>
</tr>
</tbody>
</table>

1
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Table 1.2 Per capita rubber consumption, 1990 (kg per head)

<table>
<thead>
<tr>
<th>Region</th>
<th>Per Capita Rubber Consumption (kg per head)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Europe</td>
<td>7.4 (3182.9)</td>
</tr>
<tr>
<td>West Germany</td>
<td>11.6 (720.2)</td>
</tr>
<tr>
<td>France</td>
<td>9.4 (529.2)</td>
</tr>
<tr>
<td>Italy</td>
<td>7.6 (439.5)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>6.8 (387.0)</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>7.7 (3016.5)</td>
</tr>
<tr>
<td>Former USSR</td>
<td>8.7 (2495.0)</td>
</tr>
<tr>
<td>Former Czechoslovakia</td>
<td>11.2 (174.0)</td>
</tr>
<tr>
<td>Poland</td>
<td>4.3 (162.0)</td>
</tr>
<tr>
<td>Romania</td>
<td>5.2 (120.0)</td>
</tr>
<tr>
<td>North America</td>
<td>10.5 (2892.3)</td>
</tr>
<tr>
<td>United States</td>
<td>10.6 (2628.3)</td>
</tr>
<tr>
<td>Canada</td>
<td>10.1 (264.0)</td>
</tr>
<tr>
<td>Asia–Oceania</td>
<td>1.8 (4955.4)</td>
</tr>
<tr>
<td>Japan</td>
<td>14.7 (1810.0)</td>
</tr>
<tr>
<td>China</td>
<td>0.9 (947.0)</td>
</tr>
<tr>
<td>Korea</td>
<td>11.7 (498.0)</td>
</tr>
<tr>
<td>India</td>
<td>0.5 (447.9)</td>
</tr>
<tr>
<td>Latin America</td>
<td>2.0 (835.0)</td>
</tr>
<tr>
<td>Brazil</td>
<td>2.7 (402.0)</td>
</tr>
<tr>
<td>Mexico</td>
<td>2.1 (174.0)</td>
</tr>
<tr>
<td>Middle East</td>
<td>0.3 (60.9)</td>
</tr>
<tr>
<td>Egypt</td>
<td>0.4 (21.0)</td>
</tr>
<tr>
<td>Africa</td>
<td>0.5 (241.0)</td>
</tr>
<tr>
<td>Nigeria</td>
<td>0.2 (22.0)</td>
</tr>
<tr>
<td>South Africa</td>
<td>3.2 (112.0)</td>
</tr>
<tr>
<td>World</td>
<td>2.9 (15111.0)</td>
</tr>
</tbody>
</table>


Notes: a. Both synthetic and natural.
   b. Figures in parentheses are total annual consumption (’000 t).

be only small components of huge petrochemical installations. Indeed, some SR factories are so large that they produce as much rubber as whole countries engaged in NR production. Hence the giant Goodyear Tire and Rubber Company styrene-butadiene SR plant at Houston, Texas, which has a staff of some 500 workers, produces about the same quantity of rubber as the 180,000 farmers engaged with NR in the whole of southern India. Again, while all NR must be grown in tropical high rainfall regions within 10 degrees of the equator, and hence far from most ultimate consumers, SR is largely made in industrial areas of Western and Eastern Europe, North America, and north-east Asia. It is, accordingly, close to the manufacturing plants that utilize it, and to the people that consume it as rubber goods. The chief world locations of NR and SR production, of oil and natural gas fields, and of major rubber goods manufacturing, are shown in Figure 1.1.

KINDS OF RUBBER

The term ‘rubber’ is used to describe ‘a group of materials which are highly elastic: a strip of rubber can be stretched several-fold without breaking, and
INTRODUCTION

Figure 1.1 World locations of oil and natural gas production, and of rubber production and manufacturing, early 1990s

Notes: a. All substantial oil, natural gas, and natural rubber producing areas are included. Unfortunately, precise data on area capacities were not secured.
b. Commodity and medium tonnage synthetic rubber factories or complexes with annual capacities of at least 30,000 tonnes. Smaller capacity plants are excluded.
c. Rubber manufacturing plants or complexes with annual capacities of at least 2 million tyres or 30,000 tonnes of production. Smaller capacity plants are excluded.
THE WORLD RUBBER INDUSTRY

will return quickly to its original length on releasing the stretching force' (Jones and Allen, 1990: 1). Yet the raw rubber from an SR factory or NR smallholding is plastic and malleable, and does not yet have this all-important and distinguishing feature of elasticity. To secure this and other desirable properties it must go through the chemical process of 'vulcanization', which is undertaken when rubbers are manufactured into final goods.

There are many different rubbers, and SR in particular is divided into numerous types. Most prominently, the SR types include emulsion styrene-butadiene rubber E(SBR), butadiene rubber (BR), and cis-polyisoprene rubber (IR), all of which together with NR are known as ‘commodity’ elastomers owing to their huge global capacity and production of millions of tonnes (Table 1.3). Then there are five ‘medium-tonnage’ SRs, whose capacity is from 0.5 million to 1 million tonnes, and a large number of ‘small-tonnage’ synthetic materials below the half million tonne capacity level.

Despite their common property of elasticity, the different types of rubbers are each distinguished by important special properties which mean they are used for particular purposes. Thus NR is outstanding in its low

<table>
<thead>
<tr>
<th>Table 1.3 Major rubbers and their production, 1990 ('000 t)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commodity</strong></td>
</tr>
<tr>
<td>Natural rubber (NR)</td>
</tr>
<tr>
<td>Emulsion styrene-butadiene E(SBR)^a</td>
</tr>
<tr>
<td>Butadiene (BR)</td>
</tr>
<tr>
<td>Polyisoprene (IR)</td>
</tr>
<tr>
<td><strong>Medium-tonnage</strong></td>
</tr>
<tr>
<td>Ethylene-propylene (EPDM)</td>
</tr>
<tr>
<td>Solution styrene-butadiene S (SBR)</td>
</tr>
<tr>
<td>Butyl (IIR)</td>
</tr>
<tr>
<td>Nitrile (NBR)</td>
</tr>
<tr>
<td>Chloroprene (CR)</td>
</tr>
<tr>
<td><strong>Small-tonnage</strong></td>
</tr>
<tr>
<td>Thermoplastic elastomers (TPE)^c</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Sources: Tables 2.1 and 3.4.

Notes: a. Including carboxylated latex.
b. Estimated as 72 per cent of production capacity in 1990, which was the actual overall average SR capacity utilization.
c. A group description including styrene block copolymers, ethylene copolymers, polyolefin thermoplastic polymers, and polyester/polythene elastomers (Table 3.1). In fact, the block copolymers together had a combined 1990 capacity of 520,000 tonnes, but individual TPEs are appropriately considered small-tonnage elastomers.
d. Actual total 1990 rubber production was 15,170,000 tonnes (International Rubber Study Group, 1946–93), with the difference being due to the rounding of per cent capacity utilization.
INTRODUCTION

heat build-up, tensile strength, and resistance to fatigue, and is favoured in heavy-duty commercial vehicle tyres. SBR, on the other hand, provides the good wet grip needed in passenger car treads, where it is consequently a prime component. Quite often the best balance of rubber properties is achieved by using the separate types of rubber together in a blend.

HISTORICAL DEVELOPMENTS

Rubber production has always been fuelled by demand springing from consumer needs. This demand has itself been importantly derived from the automobile industry, which began in the late nineteenth century and expanded rapidly to occupy a key role in the world economy. Even by 1910 there were 1 million vehicles in North America (Table 1.4), and 2 million tyres were made for their use. The vehicles in Europe and elsewhere at that time would have added a half-million tyres to this figure, which was rising fast. This rapid growth in tyre use led to the huge rubber prices of the early twentieth century (Figure 1.2), and encouraged widespread planting of rubber trees in South-East Asia. But these beginning figures were still minute compared to the more than 500 million cars and other vehicles on the roads in 1990, and to the 860 million tyres produced in that year. The vast expansion in automobile numbers underpinned the massive extensions in supply of rubber up to the present (Figure 1.3), but numerous other uses also arose for this industrial material. More recent SR and NR consumption in tyres and ‘general rubber goods’ in selected countries is detailed in Table 1.5.

The progress of world rubber has been critically affected by economic, political, and social changes, which have influenced both the rate of expansion and participation in it of different regions and peoples. Hence the early high prices and growth of NR were followed by the First World War in Europe (1914–18), which cut Germany off from the natural product and stimulated the first primitive factory production of synthetic elastomers. Then the Great Depression (1929–36) slowed the rise in NR planting and production, whilst small SR sectors grew up in Germany and Russia under government policies of protection and self-sufficiency. After this the Second World War (1939–45) and subsequent Japanese invasion of South-East Asia cut off NR supplies (Figure 1.3) and led to gigantic SR capacity being established in North America.

Then, following the Second World War, there was political and social unrest in South-East Asia, which slowed the recovery of NR and encouraged great further expansion of SR in Europe and Japan as well as North America. By now, indeed, particular types of SR as well as NR were filling specific needs, where they had well-established markets and limited substitutability with other elastomers. There was, too, a marked development of speciality small-tonnage rubbers for limited albeit important uses. SR output in the
### Table 1.4 Vehicles in use and production of tyres, 1910–90

<table>
<thead>
<tr>
<th>Region and year</th>
<th>Vehicles in use</th>
<th></th>
<th></th>
<th>Production of tyres</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Passenger ('000,000 units)</td>
<td>Commercial ('000,000 units)</td>
<td>Total ('000,000 units)</td>
<td>Passenger ('000,000 units)</td>
<td>Commercial ('000,000 units)</td>
<td>Total ('000,000 units)</td>
</tr>
<tr>
<td>Western Europe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1950</td>
<td>6</td>
<td>3</td>
<td>9 (67)</td>
<td>14</td>
<td>6</td>
<td>20 (70)</td>
</tr>
<tr>
<td>1960</td>
<td>23</td>
<td>6</td>
<td>29 (79)</td>
<td>53</td>
<td>10</td>
<td>63 (84)</td>
</tr>
<tr>
<td>1970</td>
<td>65</td>
<td>9</td>
<td>74 (88)</td>
<td>144</td>
<td>19</td>
<td>163 (88)</td>
</tr>
<tr>
<td>1980</td>
<td>108</td>
<td>13</td>
<td>121 (89)</td>
<td>164</td>
<td>25</td>
<td>189 (87)</td>
</tr>
<tr>
<td>1990</td>
<td>150</td>
<td>21</td>
<td>171 (88)</td>
<td>199</td>
<td>26</td>
<td>225 (88)</td>
</tr>
<tr>
<td></td>
<td>[3.3]</td>
<td>[4.6]</td>
<td>[3.5]</td>
<td>[1.9]</td>
<td>[0.3]</td>
<td>[1.8]</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1950</td>
<td>–</td>
<td>1</td>
<td>1 (–)</td>
<td>2</td>
<td>–</td>
<td>2 (n/a)</td>
</tr>
<tr>
<td>1960</td>
<td>1</td>
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**Notes:**

- a. From 1910 for North America only.
- b. All figures prior to 1960 refer to tyre shipments, where these = regional (or country) production + imports − exports. Figures include both original equipment and replacement tyres.
- d. Car tyres.
- e. Truck tyres.
- f. Figures in parentheses in this column are per cent passenger vehicles form of total vehicles in use.
- g. Figures in parentheses in this column are per cent passenger car tyres form of total tyres produced.
- h. Figures in brackets are annual compound growth rates from 1980–90.
- i. These figures may include commercial vehicles/tyres.
Figure 1.2 Index numbers of natural rubber, synthetic rubber, crude (petroleum) oil and combined commodities prices, 1900–92


Notes: a. From 1948, indexes are in real terms, being deflated by the Manufacturing Unit Value Index in US$ terms of manufactures exported from G-5 countries (World Bank, 1986–93). Before 1948, inflation was minor.
b. All main commodities in international trade (excluding energy).
c. Average SBR 1500/2 export prices, New York, up to 1965.
Figure 1.3 World production and stocks of natural and synthetic rubber, 1900–92

Sources: Production: Appendix Table A.2: Visible stocks up to 1933: Blandin (1924), Barker (1938), Rowe (1931), and Rae (1938). All other data on stocks: International Rubber Study Group (1946–93).

Note: a. Stocks are 'visible' up to 1945, and 'commercial' thereafter (including stocks in producing and consuming territories and afloat, but for natural rubber excluding those in government stockpiles).
<p>| Year | Tyres | | | General rubber goods | | | | | | Grand total SR and NR (all sectors) |
|---|---|---|---|---|---|---|
| | SR | NR | Total | SR | NR | Total | |
| Germany (^b) | | | | | | | |
| 1955 | 18 | (21) (^c) | 69 | 87 | 18 | (21) | 66 | 84 | 171 | ([51]^{d}) |
| 1960 | 63 | (45) | 77 | 140 | 43 | (38) | 71 | 114 | 254 | ([55]^{d}) |
| 1965 | 124 | (60) | 83 | 207 | 84 | (53) | 75 | 159 | 366 | ([57]^{d}) |
| 1970 | 181 | (64) | 103 | 284 | 177 | (64) | 98 | 275 | 559 | ([51]^{d}) |
| 1975 | 156 | (60) | 106 | 262 | 204 | (69) | 91 | 295 | 557 | ([47]^{d}) |
| 1980 | 155 | (56) | 120 | 275 | 267 | (82) | 59 | 326 | 601 | ([46]^{d}) |
| 1985 | 134 | (49) | 137 | 271 | 279 | (80) | 68 | 347 | 618 | ([44]^{d}) |
| 1990 | 152 | (50) | 152 | 304 | 359 | (86) | 57 | 416 | 720 | ([42]^{d}) |
| 1991 (^e) | 153 | (50) | 151 | 304 | 350 | (85) | 60 | 410 | 714 | ([43]^{d}) |
| United States | | | | | | | |
| 1950 | 346 | (42) | 485 | 831 | 200 | (45) | 247 | 447 | 1278 | ([65]^{d}) |
| 1955 | 550 | (57) | 410 | 960 | 345 | (60) | 225 | 570 | 1530 | ([63]^{d}) |
| 1960 | 682 | (67) | 329 | 1011 | 415 | (72) | 158 | 573 | 1584 | ([64]^{d}) |
| 1965 | 966 | (73) | 361 | 1327 | 599 | (79) | 162 | 761 | 2088 | ([64]^{d}) |
| 1970 | 1210 | (75) | 393 | 1693 | 739 | (81) | 175 | 914 | 2517 | ([64]^{d}) |
| 1975 | 1196 | (71) | 497 | 1693 | 768 | (82) | 169 | 937 | 2630 | ([64]^{d}) |
| 1980 | 1082 | (71) | 439 | 1521 | 898 | (86) | 146 | 1044 | 2565 | ([59]^{d}) |
| 1985 | 959 | (63) | 554 | 1513 | 868 | (82) | 189 | 1057 | 2570 | ([59]^{d}) |
| 1990 | 988 | (60) | 655 | 1643 | 1054 | (84) | 204 | 1258 | 2901 | ([57]^{d}) |</p>
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Notes:
- a. Including tyre products.
- b. West Germany only in 1955–90.
- c. Figures in parentheses are percentages of SR in total rubber consumption of the sector.
- d. Figures in brackets are percentages of tyre sector consumption in the grand total.
- e. 1991 figures are only available for Germany and Japan.
1960s forged past that of NR, and it soon became by far the most important rubber.

But after a difficult transition from colonial regimes, South-East Asia became politically more stable in the 1960s and output of NR again grew more quickly (Figure 1.3 and Table A.1 in Appendix). Higher oil prices from the 1970s (Figure 1.2) also increased costs of making SR, while widespread adoption of radial tyres enhanced the demand for NR at the expense of SBR in particular. Yet then, from the 1980s, NR in some countries began to suffer from higher wages and land costs, although this was offset by higher production elsewhere. Production of all rubbers in the early 1990s was depressed by low prices, and that of SR dropped substantially. The annual global supply of all rubbers was now more or less static, owing to the sluggish SR output.

A major change to rubber through this century has been its advance in quality, once more motivated by consumer needs in terms of autos and other products required. As different rubbers have come to occupy niches in consumer demand, such quality has been tailored to the needs in question. A further shift has been a widening development of industry and rubber goods manufacture around the world, where original centres in Europe and North America extended to Japan and then to the rest of north-east Asia; hence today the latter areas are the most dynamic, with the greatest absolute rubber consumption. This too has acted to raise demand for higher quality rubber.

THE ECONOMIC FRAMEWORK

It is useful in analysis to distinguish an overall economic framework of the rubber industry. This is presented in Figure 1.4, which shows the key factors influencing supply and demand, and interacting together in the market. Thus supply is seen as motivated not only by rubber prices (unit values of elastomers) but also by plant capacity (extent of rubber factories and planted hectarage), input prices (unit costs of land, labour, capital, and other necessary provisions) and technology (application of techniques affecting production and production efficiency). These key factors impinge on production of all rubbers, although the importance of individual components varies greatly in each case.

Again, the factors affecting demand for elastomers may be seen as including income level (standard of living of the general population), rubber price (unit values of elastomers), substitute prices (unit costs of materials such as plastics that may replace rubber), final goods prices (unit values of tyres and other goods in which rubber is incorporated), technology (application of techniques affecting design and manufacturing efficiency), consumer preferences (tastes of users consuming rubber and goods within which it is contained), stocks (amounts of rubber being stored), and
INTRODUCTION

Figure 1.4 The economic framework of the rubber industry

SUPPLY  MARKETING  DEMAND

Rubber prices  Income level  Rubber prices
Plant capacity  Rubber prices  Substitute prices
Input prices  Final goods prices
Technology  Technology  Consumer preferences
(SR and NR  Stocks  Stocks
production)  Manufacturing manufacturing utilization (degree to which end-product plant is employed).

These factors of demand all revolve around the rubber manufacturing sector. The supply and demand factors interact in marketing, which is the sphere of buying, selling, and formation of the rubber price, and which also informs actions on both sides of the model. Marketing is further viewed as including the associated activities of handling and transportation (Figure 1.4).

Finally, all activities in this supply, demand, and marketing framework entail certain organizational or institutional arrangements, which partly condition the way things happen. These and the key factor of technology are now addressed in more detail.

INSTITUTIONS AND TECHNOLOGY

The organizational structure of rubber has major economic and social significance, importantly determining its development in all spheres. Hence various institutions have been involved in producing and marketing the raw material, and then in making it into goods needed by people throughout the world. Government, as one very important organization, has been active at all levels, often greatly influencing what has occurred.
THE WORLD RUBBER INDUSTRY

The institutions producing rubber today include some 25 giant vertically integrated firms making SR, most of which generate this as a ‘downstream’ offshoot of wider petrochemical enterprises, but some of which prepare it ‘upstream’ from rubber goods manufacturing. The organizations producing NR include ‘estates’, which are relatively large farms growing the crop on hundreds of hectares. Yet as indicated above, most NR is produced by smallholders on tiny plots, and millions of individual farm households cultivate NR on 2–3 hectare parcels. The latter in particular rely on a network of traders to collect their crop, further process and grade it, and arrange its despatch to ultimate manufacturing consumers. Some estates also market their output through traders, and SR producers often use trader-intermediaries when dealing with smaller manufacturing concerns.

The manufacturing organizations using SR and NR as raw materials include six huge tyre and rubber goods makers operating on a global scale, together with many smaller companies either specializing in particular items or functioning predominantly within given regions. Such concerns again rely on traders to bring their rubber goods to final consumers. All these very different kinds of producing, marketing and manufacturing institutions have arisen in relation to political and social as well as economic forces, and their institutional frameworks have greatly influenced the evolution of world rubber.

Lastly, governments in nearly all countries have directed the development of rubber amongst other economic activities, and influenced it very substantially. Hence state subsidies have usually been critical to early establishment of SR, and were vital to rehabilitating and expanding NR from the 1960s. On the other hand, officially imposed restrictions stifled the growth of NR during the 1930s, and government tariffs have restrained trade in all rubbers and rubber products for most of the last 70 years.

Any perusal of rubber development must also take special account of technology, which has had key influence on it. Technology affected NR supply, for example, by enabling a doubling or tripling of yields above those of the first Amazon trees, and by raising the low initial quality of NR output to that of a clean technically specified material suited to modern manufacturing. It also made possible the production of a range of SRs, each with arrays of important properties. It led to the invention of vulcanization, which allowed the conversion of rubber into usable goods. Technology affected the demand side by generating the modern tyres and other rubber articles which are used in ever more strenuous and sophisticated roles in cars and other products.

Technological change has not always been positive in its effects on rubber, and this is especially evident on the demand side. Thus the evolution of smaller cars and tyres against needs for fuel efficiency with higher oil prices in the 1970s and 1980s cut what could otherwise have been a greater rise in overall consumption of all rubbers. Sometimes, too, one type of rubber has
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gained while another has lost, as was true of the radial tyre which favoured NR at the expense of SBR. In a reverse case involving these same elastomers, introduction of precured SBR retreads in the 1980s displaced NR from a major sphere of usage. Technology is hence a potent factor on both supply and demand sides of the rubber industry.

THE PRESENT BOOK

This book is an economic appraisal of the world rubber industry, and attempts to pinpoint major elements in its growth to the present and future progress. Thus, despite covering all aspects thought pertinent to this, the book is not a technical or social treatise, or even a prognosis of rubber market trends. There are excellent publications undertaking these tasks, and they are cited in the text. The attempt is rather to draw together the many disparate elements constituting a vast industry, and to analyse these in relation to the whole. This is difficult, and has not to the authors' knowledge been previously attempted. It is none the less believed well worth addressing.

There are certain emphases in the book which deserve explanation. Thus while NR is only one of 4 major commodity rubbers, rather more weight is placed on it than on SBR, BR, and IR, all of which are to a great extent treated under the general head of SR. But this is felt justified by the rather special nature of NR compared with the other elastomers, which have many features in common. Again, more attention is given in the book to features surrounding SR and NR supply than to rubber manufacturing and other elements of demand. This is partly because production has been neglected in the literature, and partly because rubber manufacturing is a sphere comprising many aspects other than rubber. It is none the less judged that demand is treated quite sufficiently to allow comprehensive understanding of the whole industry.

It is also considered that many issues raised in the book have wider significance beyond rubber. These are issues of technological progress, private motivation, government intervention, and political and social systems, all of which arise in numerous contexts and are crucial to overall economic development. Thus the analyses made should throw light on economic progress with other major commodities.

Ordering and scope

The histories of NR and SR, respectively, are treated in Chapters 2 and 3, which likewise highlight major economic, technical, and socio-political events underlying these developments. Then methods and costs of producing major types of SR, as well as wider economic aspects of the SR sector both regionally and globally, are examined in Chapters 4 and 5. The same
THE WORLD RUBBER INDUSTRY is done for NR in Chapters 6 and 7. The historical development of rubber goods manufacturing, and processes of fabricating rubber into tyres and other goods, are treated in Chapter 8. The economics of rubber consumption are scrutinized in Chapter 9, which covers the use of rubber in tyres and general rubber goods, the organization of tyre manufacturing, and major trends. The marketing of rubber is addressed in Chapters 10 and 11, which review SR and NR trading structures as well as the mechanisms of price formation and recent attempts at market regulation. Finally, some basic economic, technical and social issues arising from the analysis are addressed in Chapter 12, which further considers desirable policy scenarios and projects the future evolution of the world rubber industry.

It is just over 250 years since the great French explorer, Charles de la Condamine, first described the use of caoutchouc or 'weeping wood' by South American Indians to make shoes and other household articles. In the intervening time a vast international industry has arisen. It is hoped that the picture of the industry conveyed through the book, as well as the various analyses, will help readers to better understand the economic forces shaping a key raw material production and processing sector of the modern world.
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