

## CHAPTER VI

### COMPETITION BETWEEN NATURAL AND SYNTHETIC.

#### INTRODUCTION

The threat of synthetic rubber has been enhanced not only by the increased capacity of its production through the erection of new plants throughout the world but also through the introduction of stereo-regular rubbers which are claimed to be a complete replacement for natural rubber.

We have to accept the fact that increasing competition from synthetic rubber will mean that the price of natural will follow a downward trend towards the end of the decade. The industry must, therefore, be prepared to be in a position to sell at a price highly competitive with that of its synthetic counterpart.

In the analysis of synthetic competition of the difficult problems which is encountered here is that there is a broad number of types available in use, coupled with the extraordinary diversity of end uses. As such, I have in mind "synthetic" which covers all these broad types, so that my treatment of the synthetic elastomers will be very general indeed. However, it can be judged from the nature of the competition of synthetic and its rapid development to see the relative standing of natural in the world market.

It is thus, a meaningful economic analysis of competition between synthetic and natural can be made with reference to a whole range of polymeric elastomers, which have been or will be available to the processor or fabricator of "rubber" products.

#### FACTOR SUBSTITUTION BETWEEN SYNTHETIC AND NATURAL.

Natural rubber competition since the end of the second World War has provided Economists with an interesting case study of the close interplay between the technical and economic aspects of factor substitution in production. In any production process, there are various degrees to which one factor of production can be substituted for another. In the case of factor substitution between synthetic and natural the possibilities of technical substitution have undergone fundamental changes as new synthetics have emerged on the scene. The elasticity of substitution is exclusively a technical question relating to the particular character of the productive process and its unique technology. The process

of substitution between natural and synthetic can be treated under three possible situations.

1. Where synthetic rubber enjoys a technical superiority and there is no competition from natural rubber.
2. Where natural rubber enjoys a technical superiority and there is no competition from synthetic rubber.
3. Where there is some degree of competition between natural and synthetic.

In this case, we are more concerned with situation 3 where the ultimate choice between synthetic and natural has evolved around price and cost considerations.

Figure 5-1 provides an illustration of the nature of the three situations between synthetic and natural. (For a detailed explanation of the diagram, refer to Chapter IV under the subheading "The Relationship of Synthetic and Natural")

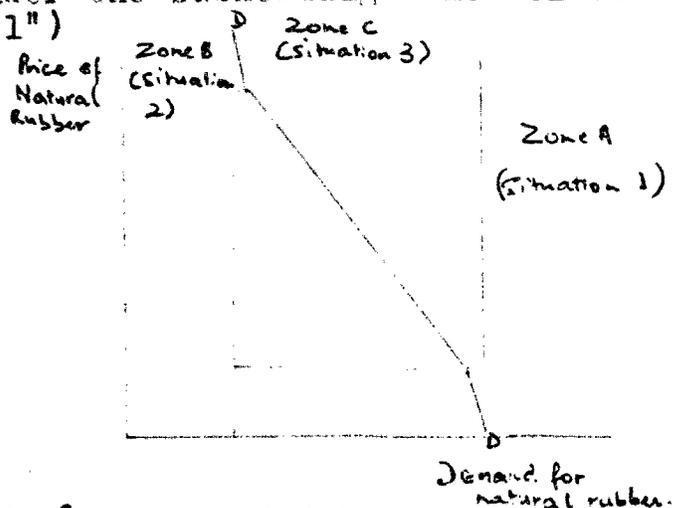


Fig 5-1. Zonal Relationship Between Natural and Synthetic.

Zone A and Zone B are the relatively no competition areas due to individual technical superiority.

Zone C shows the situation where competition between synthetic and natural is most intense. Here, if the cost of natural were lower than the cost of synthetic relative to the value of the final product then natural will be selected. This is due to the marginal valuation of a product to its cost.

Recent synthetic developments indicate that Zone B, where natural has a technical superiority over synthetic may be eliminated so that there may be an increase in Zone C where competition between synthetic and natural is intense - the elasticity of substitution between natural and synthetic will shortly become almost infinite. This is to say that synthetic will invariably become an almost perfect substitute for natural

in all its uses.

Therefore, the question of comparative costs and comparative advantages between the two may be likely to be more decisive in future uses of (1) - natural or synthetic.

### GENERAL CLASSIFICATION OF SYNTHETICS.

The term "synthetic rubber" is of course, a misnomer. As commonly used the term covers five major and many minor polymers and co-polymers, each a discrete elastomer in itself. They include, therefore, co-polymerised butadiene and styrene (SBR rubber) polyiso-butylene (Butyl Rubber) polychloroprene (Neoprene), co-polymerised butadiene and acrylonitrile (Hycar, Chemigum or Perbunan) and polysulfides (Thiokol). Recently the synthesizing of stereoregular cis-polyisoprene and cis-butadiene on a commercial scale has added two significant new polymers to the list of synthetic rubbers. Many more of such stereo-specific polymers is likely to make its appearance in the near future. The term synthetic, therefore, cover all these polymers as well as other less important ones in the sense of quantitative usage. Such is the range of applicability of "synthetics" when we compare it with natural rubber.

A knowledge of the technical properties is essential as synthetic competition is based on its technical suitability when compared to natural. The extent of its qualities over and above that of its counterpart will determine the extent of its usage in industries.

### TECHNICAL SUPERIORITY OF SYNTHETICS.

The neoprene synthetic polymers possess superior resistance to heat, oil, most chlorinated hydrocarbon and a large number of chemicals. These qualities have enabled their wide usage in mechanical products such as hoses, conveyor belts and automotive parts, industrial gloves and so on, where resistance to certain agents are desired. Other qualities which further extend their usage is in their ability to withstand age and flame resulting in their widespread use in safety aprons, bonded fibres or foam products where long wear is sought.

Butyl rubber is highly impermeable to most gases and more effective as an air retainer than natural rubber. On such a basis of technical suitability, Butyl rubber has rapidly replaced natural rubber in inner tube manufacturing and with the advent of tubeless tyres, it has been used as an air sealant for them. Its other qualities include superior ozone and weathering characteristics and does not harden or crack when exposed to heat and oxygen. It has been a wide-

spread replacement for natural rubber where such deteriorating factors are widespread.

The general purpose butadiene-styrene co-polymers has superior abrasion resistance, which is significantly better than that of natural rubber that almost all automobile tyres manufactured today use "synthetic" treads made from butadiene styrene rubber.

#### TECHNICAL SUPERIORITY OF NATURAL.

The other side of the technical coin can be referred here. Natural rubber has a unique superiority over any commercially produced synthetic polymers, where high reliance and low hysteresis qualities are necessary. In aeroplane and heavy truck tyres, numerous mechanical goods and parts of ordinary car tyres, where it is desirable to have an elastomer capable of high energy reversibility \*, has extensive usage of natural. The fact that natural rubber is characterised by stereo-regularity in its polymer chain and that none of the synthetic polymerisation processes could hereto fore duplicate, had led to natural rubber being superior over all synthetic elastomers in the past. In otherwords, the substitution of any synthetic elastomer for natural rubber in the above mentioned field was technically not feasible. Since the tyre industry still remains (though to a much lesser degree than before) the most important single source for the demand of rubber, the demand for natural based on technical qualities rather than comparative costs has been extremely large.

In one latex product field, natural rubber enjoys a significant technical advantage over synthetic. The largest and most rapidly expanding uses for elastomers since World War II have been in the field of latexes, used mainly for foam products. Until quite recently, it was not technically feasible for large amounts of synthetic latex to be utilized into foam, because the colloid chemistry did not permit synthetic latexes to be made with higher rubber solids content. It meant to say that it was extremely difficult to get a relatively high percentage of the tiny rubber particles suspended in a solution without making it a putty like material. Moreover, it was not only difficult but costly to undertake. This had led to an almost complete dependence on natural rubber

---

\* High energy reversibility means when the elastomer is deformed it does not dissipate the energy input as heat but utilizes the energy to return to its initial predeformed shape.

latex where ordinary foam rubber products were concerned.

However, recent technical developments in synthetic have also led to new areas of possible technical substitution in the field of latex foam. This advance involves an additive to synthetic latex to make it free flowing and easy foaming.

### ADVANCEMENT OF SYNTHETICS.

Polymer chemists after many years of work have finally discovered the means of controlling the regularity of monomer positioning in synthetic polymer chains. This advancement must be viewed with extreme priority and importance because synthetic polymers can now compete with natural in the field of applicability. By controlling the specific position of monomer molecules in the polymer chain, stereo-regulars (the new improvement) hold promise of destroying the barrier of technical superiority held by natural rubber.

This means to say that the stereo-regular polymers are presenting a new challenge to the natural rubber industry and that the typical division of zonal competitiveness may be eliminated completely as synthetic take the field of equal competitiveness in the elastomer industry with natural. Cis 1,4, polyisoprenes for example, is in effect an almost direct chemical duplication of natural rubber with similar resilience and low hysteretic properties. Cis 1, 4, Butadiene, another stereo-regular is becoming commercialised. Other stereo-regulars are bound to follow in quick succession and it will be foreseeable that these may compete intensely with natural in a few years from now. There is no doubt that the question now is one of speed and degree rather than one of direction.

On the basis of recent developments in the field of polymer chemistry which we have outlined, it is obvious that the competition with natural rubber at the technical level is not as immune as it once was. Polymers that can be commercially synthesized are now, or shortly will be, technically substitutable for natural rubber in practically all of its present uses. Furthermore synthetics are establishing specialised technical markets of their own which is highly immune to natural rubber competition. The fact that synthetics are gradually expanding into markets where natural rubber cannot compete on a technical level is a significant development within the industry itself.

### PRICE CONSIDERATIONS

Technical substitutability is only one side of the

picture. Economic considerations together with technical substitutability may be the criteria for the usage of either natural or synthetic.

The one immediate assumption is that stereoregulars and natural rubber will be sold in a free market economy. Prices which consumers are willing to pay will be roughly equal, plus or minus differentials in transport and handling costs. Synthetic prices are relatively stable but natural rubber prices may not be so. The basis of comparison may give synthetic an added advantage in that consumers may be assured of price rigidity so that the price of their ultimate manufactured product may be more or less stabilized, other factors taken to be constant. Moreover as the combination of both synthetic and natural have increased the existent supply to the given demand, the effect would be to keep prices at a lower level than would be the case if the supply were to be obtained from one source alone.

If market forces will tend to bring natural and synthetic rubber prices together, the chief determinant in the long run may be based on the comparative cost structure of the two industries.

### COST CONSIDERATIONS

Long term predictions, it must be admitted, are extremely dangerous to make especially in industries where technology and the productive process are rapidly changing. Nevertheless it is possible to isolate some of the most important economic characteristics of the natural and synthetic industries which appear certain to shape future developments.

The single most important difference in factor inputs characteristic of the synthetic polymer industry as a whole, is the high capital equipment input and relatively low labour input per unit of production. The factor proportions vary with the different polymers, but it is unlikely that even the most labour intensive of the synthetics involves a labour cost input of 6-7 percent of total costs, while capital inputs probably accounts for half of the total factor costs in integrated plants which manufacture the basic monomers as well as the polymers. Intergrated plants like most of the large American plants take basic raw materials such as natural gas or crude oil fractions and carry the production process first through the intermediate monomer stage (butadiene, isobutylene) before manufacturing the polymer itself.

One man year of labour in the natural rubber industry produces between one and two tons of natural rubber,

whereas a man-year of labour in the synthetic industry is related to 500-1000 tons of output, (and the output per man year in synthetics is constantly growing).

Raw materials is an important production cost in the synthetic polymer industry. The raw materials vary, but the most important intermediate monomers, such as butadiene, styrene, butylene and acetone are all generally capable of being synthesized from a basic coal, petroleum or natural gas hydrocarbon. Over the past several years, the growing world surpluses of coal and crude oils have led to a substantial lowering of prices for these products. Long term cost prospects for synthetic polymeric raw materials, are now expected to remain stable or fall rather than increase.

Synthetic production requires an intense utilization of heavy capital overheads, but it is balanced by the substantial economies of scale involved in the production of the synthetic polymers. The efficient production of synthetic polymers, it must be realised, requires large scale plant installations and a high utilization of capacity. Plants producing anywhere from 50 - 300,000 tons per year are typical. It must be realised, therefore, that these economies of scale and limited divisibility of productive units in synthetic rubber production give rise to four implications.

1. Increases in synthetic polymer capacity can be attained at almost any magnitude. This is so because we have physical excess capacity which means to say that the marginal units are invariably large, since they involve whole plants.

2; Once the historic cost of establishing a plant has been incurred, fixed capital costs are so high that strong economic reasons exist for continuing such plants in operation at high level output. With increasing output therefore, the sunk cost will be spread more economically and that low variable costs per unit will provide a larger contribution to the recovery of the capitalized costs. (While the same economic forces apply to natural rubber operations with sunk cost, variable costs in the latter are likely to be considerably higher than in integrated synthetic plants)

3. Synthetic has a critical time advantage over natural rubber in placing its product into the market. A rubber estate takes a minimum of 6-7 years to come into production, but a synthetic plant can become operative within two years after the decision is made to build, and

4. Synthetic production has the advantage in that the plant can be strategically located in proximity to major sources of raw materials or major consumption areas, thus

decreasing transport costs substantially.

Other characteristics of the synthetic polymer industry can be listed but the ones given above are the more important of the implications of the synthetic supremacy over natural.

### LONG RUN DETERMINANTS

With the emergence for the first time of a comprehensive range of technical product substitution possibilities, instead of the limited range, heretofore, possible, the role of the relative costs involved in producing natural rubber and its synthetic counterpart now becomes the dominant variable in the long term pattern of development. Comparative analysis of long term costs prospects is difficult to make with any degree of certainty. Factor cost patterns of competing products and their capability to respond to market forces efficiently will undoubtedly play a critical determinant role in establishing the long term competitive position of natural rubber and synthetic. Significant differences in average costs structures are immediately apparent. Natural rubber production is characterised by heavy labour input per unit of output. Its synthetic counterpart is characterised by low labour input and high capital equipment input per unit of output. Natural rubber has almost no counterpart of the synthetics' raw material cost; but ~~natural~~ have relatively heavy administration costs that are lacking in the production of synthetic. The production of natural rubber can be organised in a variety of different ways and cost efficiency can be maintained at any of a wide range of productive firm sizes. The production of synthetic, however, involves highly indivisible costs in the form of capital equipment, and costs efficiency in production depends upon relatively large productive unit sizes and high utilization of available capacity.