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Long-run Supply Prospects

by W. Robertson, Liverpool

Doubts are frequently expressed about the future supply of industrial materials if world demand grows at the rate which is believed necessary to meet expectations of rising living standards. If it is not the complete exhaustion of sources of supply which is not in question it is at least feared that materials will be available eventually only at prices which would appear unreasonable to manufacturers and consumers.

Experts have argued that some minerals could be nearly exhausted by the end of this century. It has been emphasised that, as a great increase in consumption of minerals and mineral fuels has occurred in the recent past, absolute annual additions to already high levels of consumption would be much greater than they were a few decades ago. Even allowing for new discoveries, the picture of resource exhaustion would not be dramatically changed. Similar gloom seems to hang over the long-run supply prospects for materials, the sources of which have not been fixed by past geological changes. As far as these renewable material supplies are concerned, it seems to be believed that diminishing returns must set in with inevitable increases in prices.

The Growth of Consumption

The evidence of growing claims on resources is certainly impressive. Take, for example, some non-ferrous metals. Since the early years of this century world copper consumption is estimated to have risen from around 700,000 metric tons per annum to around five million tons by the mid-sixties, about half of the increase occurring in the last fifteen years. Zinc consumption by the mid-sixties was over five times greater than at the beginning of the century, and again about half of the increase occurred in the last fifteen years. Nickel was not used on a large scale in the twenties, consumption being only about 30-35,000 tons. It has since exceeded a quarter of a million tons. Tin is something of an exception. World consumption has just about doubled since the early years of the century.

The pessimist might quote the enormous differences in materials usage between countries as

a harbinger of what may occur when living standards improve in the lower income countries. According to an estimate by A. Maizels, the value of consumption per head of metals in the industrial areas in 1959 was about forty to forty-five times that of consumption in India and Pakistan, which had jointly about the same size of population. The same author calculated that North American per capita consumption of steel was fifty-five times greater than that of Asia, excluding Japan, and about thirteen times greater than that of Latin America. We can also find very great differences between countries in consumption of other materials, such as natural rubber, natural fibres, wood pulp, as well as mineral fuels. If we assume, therefore, that the lower-income countries are aiming at Western living standards, we could conclude that the demand for industrial materials must expand enormously.

Alterations Due to Technological Changes

This is a reasonable deduction. It does not, however, necessarily follow that the future pattern of materials consumption in the lower income countries will be the same as it has been in the contemporary high-income countries. In the long run technological changes will drastically alter the conditions which are relevant to the inter-country comparisons we have alluded to. Hence it is most unlikely that some of the traditional uses of conventional materials, which now make up a substantial part of consumption in high-income countries, will have the same importance in the lower-income countries as their economic development proceeds. It is not unlikely that in the absence of deep-rooted traditional practices the developing countries will tend to become more receptive to new technologies and also to be attracted to new materials. Although the total consumption of materials, therefore, will rise substantially, their relative importance will change, presumably in favour of the cheaper and more abundant materials, especially aluminium and plastics. In so far as this happens, the pressure on the supply of conventional materials will be reduced.

The conventional attitude towards costs in extractive industries is that they rise in the long run because natural resources are scarce and because scarcity grows worse. Recent research into American experience between 1870 and 1960 throws doubt on this proposition. Over a range of industrial materials it appeared that the unit cost of output, far from rising, had actually fallen since 1870. There were one or two exceptions, or doubtful cases, but the general picture was not affected. There was some evidence of rising costs for lead and zinc mining in America, but the rise had apparently been checked by an increase in imports.

All countries taken together, of course, cannot escape a rise in extractive costs simply by resorting to imports. But it must be emphasised that there are still many countries with little demand for their largely untapped resources. Even a doubling of population in these countries would put little strain on their known resources.

Discovery of New Mineral Resources

There has been a fall in the richness of mineral ores mined in the US. The fact that costs have not risen, however, indicates that the richness of ores is not necessarily a determinant of costs of extraction. Orris Herfindahl's study of American copper costs and prices shows clearly that a falling grade of copper ore has not raised the deflated price of copper; that is, the price of copper has not risen relatively to the prices of other products, certainly not up to 1960.

We cannot assume that the quality of mineral resources has fallen generally. The world's mining industries do not invariably start off with rich low-cost ores and move inevitably to poor high-cost ores. New rich mineral deposits are continually being discovered. Given the serious inadequacies of our knowledge about mineral resources in many parts of the world, it is surely reasonable to assume that even with existing techniques new resources are likely to be found which are as rich as those discovered in the past. Post-war experience certainly points in this direction.

Technological progress is at least as important as the discovery of new mineral deposits in keeping down costs in mining industries. We cannot assume the low-grade deposits will necessarily remain high-cost deposits. This is particularly important because low-grade mineral deposits are far greater than high-grade deposits, and the technology of mining low-grade deposits is only in its infancy.

We can also look to large gains from technological progress in agricultural extractive industries producing cotton, natural rubber, and natural fats and oils. Consider, for example, the rise in the average

yield from rubber trees on Malaysian plantations. Pedigree rubber clones developed in the thirties could yield 1,100 lb per acre, those developed in the forties 1,500 lb, most recent ones can go beyond 2,000 lb. Thus as old trees are replaced, the average yield will rise well beyond the average yield of 740 lb reported in the early sixties. Therefore, in Malaysia and in other rubber-producing countries there is much scope for increasing output without using more land, simply by using the results of already known research.

The pessimist might argue, of course, that technological progress might not continue indefinitely. The obvious retort is — why should it tail off? Much will depend on the research effort of primary producing countries. Many still do very little because of the general backwardness of their economies. Moreover, technological progress is such an integral part of the world economy that we cannot just write it off in the future.

Marine Exploration

One major source of minerals has been virtually untapped. Exploration of the ocean floor has only begun, but there are already good grounds for believing that its mineral wealth is vast. Tin is mined by ocean-going dredges off the coast of Indonesia, and a large part of the country's tin reserves are believed to lie off-shore. Western Europe has only just begun to tap the natural gas deposits in the North Sea.

Two American economists, Harold Barnett and Chandler Morse, describe marine resources in these terms: "Most of what is eroded from the soils, discharged from the atmosphere, or simply added to the world's accumulated rubbish, is carried by rain, stream, and wind into the earth's open and landlocked waters — there to be held in solution or suspension, to be transformed into organic life, or to accumulate as silt in streams and lakes and on the ocean floor as coagulated nodules of nearly pure mineral." Possibly a dramatic way of looking at it, but it is as well to draw attention to a resource reservoir on this planet when so much wealth and effort is devoted to the exploration of outer space. Inner space may be even more fruitful, for in addition to the resources referred to by Barnett and Morse there are the mineral deposits below the ocean floor, analogous to those found by deep mining on land.

Secondary Materials

Any assessment of the world's supply of materials must take account of the growing supply of secondary materials, or scrap. The more primary materials we extract from the earth's crust the bigger the supply of secondary materials. All that we have done is to transform the ores into a new form embodied in various types of consumer and

capital goods. When these goods become redundant either through obsolescence or age, the materials embodied in them become available as scrap for incorporation in new goods. There is some wastage, because the cost of recovering the material may not be worthwhile in some cases. This happens with the tin in old metal containers which have an extremely thin tin coating. But much of the minerals used as pure metals or as alloys are recovered, and the more efficient the recovery process the lower the costs of recovering secondary materials. We may expect, therefore, that as the quantity of minerals "consumed" by industry increases, the somewhat unglamorous scrap industry will become increasingly important.

It is clear that the possibilities of switching from one material to another have been greatly increased in the last few decades by the rapid development of man-made materials — rayon, plastics in the form of synthetic fibres, synthetic rubber and so on. Plastics are a new element in calculations of resource endowment. Production has been growing very rapidly in the last twenty years. More than half the world's rubber consumption is supplied by synthetic rubber. Plastics also reduce the demand for metals and forest products. Competition from plastics, the price of which tends to fall in the long run, will act as a brake on the price of the conventional materials.

The Supply of Mineral Fuels

It may still be argued by the sceptic that the scarcity of resources is unavoidable, since the increased supply of man-made materials must depend on the supply of conventional mineral fuels from which they are derived, namely on coal, petroleum and natural gas. However, the proportion of output of petroleum and natural gas, from which plastics are mainly derived, is very small. Most petroleum and natural gas supplies are used for fuel. This is a wasteful use of materials from which so many derivatives can be extracted, but it seems to be inevitable at the present stage of economic and technological development. Nevertheless, it is premature to fear the exhaustion of petroleum and natural gas deposits. Major oilfields have been producing for decades without much evidence of exhaustion, and much natural gas is simply flared off for lack of economic out-

lets. Vast new oilfields and natural gas deposits have been discovered since the 1939-45 war. Thus estimates of world petroleum reserves have been continually revised upwards; in 1922: 22 billion barrels, 1927: 40 billion, 1945: 160 billion, 1956: 1,280 billion. And these estimates exclude known deposits which could be exploited if there were further improvements in technology. Moreover, very large areas have not been explored geologically. There is no doubt, therefore, that the concept of mineral fuel reserves is an extremely elastic one.

We should also take into account the rise of nuclear energy which draws on a raw material resource of which previously little economic use was made. Further, assuming that technological progress will continue, the possibility exists of a new means of propulsion for the world's growing stock of road vehicles.

Conclusion

In spite of the growth of population and the inevitable push towards better living conditions which must involve a growing demand for industrial materials, there seems little justification for fears of scarcities of materials, apart of course from the temporary scarcities and temporary high prices which are due to fluctuations in supply and demand. These temporary scarcities are particularly likely in primary producing industries such as the copper industry, where a miscalculation of demand leads to a temporary shortage because of the long gestation period of investment. But this is a very different situation from the long-run scarcities which are sometimes portrayed. It is worth emphasising this since mistaken ideas about the future scarcity of natural materials can damage the developing countries which are heavily dependent on natural materials. They are made to believe that the long-term supply prospects for natural materials are poor, and that therefore there must be an overhasty development of synthetic materials. While we would certainly not deny the value of these materials for both developed and developing countries, it is a question of the best allocation of resources between developing supplies of natural materials and those of synthetic materials.



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