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Article — Digitized Version

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Intereconomics

*Suggested Citation:* Banks, F. E. (1976) : The price of copper, Intereconomics, ISSN 0020-5346, Verlag Weltarchiv, Hamburg, Vol. 11, Iss. 9, pp. 248-251,  
<https://doi.org/10.1007/BF02929066>

This Version is available at:

<https://hdl.handle.net/10419/139406>

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# The Price of Copper

by Dr F. E. Banks, Uppsala \*

**This article may be of particular interest in view of the fact that UNCTAD has now for the first time set down a schedule for preparatory negotiations on raw materials. The resolution of UNCTAD IV on the treatment of the integrated action programme for raw materials is now to be realised. Negotiations on copper will take place in Geneva between Sept. 9 and Oct. 10, 1976.**

The purpose of this paper is to discuss, on a non technical level, the probable development of the price of copper. The price considered below will be the *money*, or *current*, price of copper, but the *real price* of copper is also of some interest, particularly for the less developed countries (LDCs) producing this commodity. This real price is the money price deflated by an index of the price of manufactured goods in the major industrial countries, taking exchange rate variations into account. In the last year this real price has fallen to a level equal to its value in the early 1960's which, among other things, means that the LDCs producing copper have found it necessary to export progressively larger amounts in order to obtain the same quantity of imports.

## Influence of Technology on Real Cost

An item of similar interest is the *real cost* of copper. The money cost of copper has been on an upward trend over most of the past 100 years, but the real cost has been falling. By this it is meant that today copper can be obtained from ore having a copper content of 0.5 p.c. at a cost which, measured in goods and services, is not higher than it was a century ago when the copper content was about 6 p.c. In fact, it could be argued that for the US the cost of almost all extractive output has been falling up to at least 1972, although it may be the case that this decline in costs is slowing down<sup>1</sup>.

The explanation here, of course, is technology. Not only is it less expensive in real terms to obtain certain minerals, but it appears that these materials are becoming more productive in their various uses. To see this note that the real GNP of the US doubled between 1950 and 1970, while

the consumption of copper increased by about a third. Thus GNP per pound of copper, or what can be called the aggregate productivity of copper, has been increasing by approximately 2 p.c. a year. This situation should be expected to continue, since the "copper intensity" — or copper consumption per capita — in the developed countries will probably decline in the coming years, while GNP continues to expand and population growth slows down or even stagnates.

## On the Relations between Copper Reserves and Prices

The matter of copper reserves must also be perused, but first a little economic theory is in order. Unmined copper is a stock which, if used today, will be unavailable in the future. The incentive for leaving a mineral in the ground is that its expected price rise will compensate for the profit lost by not removing and selling it immediately. Thus we can postulate that in a market in which a resource was becoming "scarce", in that its reserve/consumption ratio was "low" or falling rapidly, expectations will be that its price will rise faster than the opportunity cost of leaving it in the ground, and consequently its exploitation should be delayed. This in turn, through its effect on present supply, causes present price to rise. It is through mechanisms of this sort that the price system rations exhaustible resources over time.

It would appear, however, that deficiency in the above sense is not a present day characteristic of the world copper market; or for that matter the market for any of the more important industrial raw materials, to include oil, or tin (which has the smallest reserve/consumption ratio of any of the major minerals)<sup>2</sup>. Furthermore, if it is true that

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<sup>1</sup> See F. E. Banks, *The Economics of Natural Resources*, Plenum Publishing Co., New York and London 1976; and R. M. Solow, Richard T. Ely Lecture: *The Economics of Resources or the Resources of Economics*, *American Economic Review*, May 1974.

<sup>2</sup> A possible exception here is uranium. The ratio of easily exploitable copper reserves to consumption per year is at present 35 years, and this has been true, for some time now. However if "hypothetical" and "speculative" reserves were included, this figure would most likely be doubled.

a resource is not scarce, then from the point of view of economic theory it is a mistake to create reserves too far in advance of when they will be used. For instance, if the price of a resource is one dollar, and one dollar is invested in creating a unit of reserves that will not be used for 20 years, and the discount or interest rate is 10 p.c., then if there were no costs for extracting and processing this mineral, it should sell for  $(1+0.10)^{20} = 6.72$  \$ in order to justify the investment. It seems reasonable to claim that price rises of the magnitude indicated by this calculation are out of the question for most mineral industries. In fact it could be argued that much of the money being spent at the present time to locate certain non-fuel minerals, especially in the Third World, would be better utilized in devising programs and techniques for relieving the population pressure on existing resources.

### Energy and Processing Costs

As pointed out above the real cost of obtaining copper has been falling over time, largely due to a technical progress that has been replacing increasingly expensive manpower by what was, until recently, moderately priced energy. The question must now be posed as to the possibility of this arrangement continuing.

In tackling this issue it should be made clear that at present we are in transition from a period when energy was comparatively scarce, but inexpensive, to one where we may dispose of unlimited amounts of energy, though at a high cost<sup>3</sup>. This transition stage is at present too new for us to pretend any great familiarity with its structure, but at least one thing seems obvious: the rapid rise in oil prices experienced several years ago has stimulated the discovery and introduction of alternative energy technologies and sources at a very high rate. If this trend continues for another ten years it could alter the global energy situation in such a way as to preclude a repetition of the predicament facing many energy intensive industries after the 1973–74 oil price rises, when they found themselves facing drastically higher costs.

The relevance of these observations can be seen from the fact that in the US in 1970 the energy input into a pound of copper was, on the average, 44,300 BTU; and projections indicate that this will go to 125,800 BTU in the year 2000. This involves an increase in energy use of only 3.5 p.c. a year, which cannot be considered excessive if the cost of energy can be kept from rising too rapidly. Of course, on this point it must be remem-

bered that persistent and substantial increases in the price of energy will depress the rate of increase in the demand for almost all investment and durable goods in most industrial countries, changing the composition of output in such a way as to moderate the demand for copper, and eventually causing the elimination of some high cost copper producing facilities. It therefore appears likely that, through one means or another, we can anticipate the continued descent in real production costs where this industry is concerned.

The next topic involves the processing of copper, but first a brief description of the mechanics of the copper industry is required. About 80–85 p.c. of copper consists of "primary" copper, which is newly mined ore having a copper content of only a few p.c. A flotation process "concentrates" this ore to a point where it contains an average of about 25 p.c. recoverable copper. This concentrate is smelted in furnaces to produce blister containing about 98 p.c. copper; and finally, in one or more stages, this blister is refined to a purity of at least 99 p.c., and is ready for fabricating. As for the remaining 15–20 p.c. of the world copper supply, this has its origin in "scrap" or secondary copper.

Considerable copper is produced in "integrated" operations, where one firm handles all four of the above processes. This type of firm is interested in the cost of refined copper, and three years ago this came to about 40–45 cents/pound for 80 p.c. of all integrated operations. Many mines, however, do no more than concentrate their ore, and for further processing utilize the services of so called custom smelters. Over the last 10 years there has been a fairly large increase in both the amount and proportion of copper coming from non-integrated mines, and industry opinion seems to feel that an upward pressure on copper prices could originate from a shortage of custom smelting (and refining) capacity, caused by a sharp escalation in operating and equipment costs faced by this industry. In addition, even if this capacity did materialize, but charged too high a price for its services, it could contribute to a decrease in the rate at which new mining operations were started.

There is no doubt that conventional capital and labor costs have grown at a particularly high pace over the past few years, and in addition smelters are facing very high anti-pollution charges. It is possible that processing costs for the newer installations, to include so-called normal profits, are already in the vicinity of 20 cents a pound; and given the recent stagnation in copper prices it is necessary to ask just how large the demand for this type of processing capacity is

<sup>3</sup> This cost will, for the most part, be a capital cost. However it should be appreciated that once these investments are made, and the equipment available, the "economic" costs might be quite low.

likely to be in the near future. As non-integrated mines face higher processing costs they will tend to scale down their investment plans, and this in turn will eventually cause a decline in the rate of increase in smelter capacity.

On the other hand we see that very large investments were made in smelting and refining plant in the late 1960's and early 1970's, much of which was inspired by the large profits that many custom smelters were able to realize from about 1966 on. Over the period 1974–77 the increase in custom processing capacity will be on the order of 20 p.c. This should be more than enough to process any increase in the production of copper that will be forthcoming from non-integrated facilities during that period, and to process it at prices not much above those prevailing today.

In addition it is possible that a larger part of mined production in the less developed countries will, as a matter of policy, be smelted and refined in these countries. It may even be so that the demand for custom smelting capacity may start decreasing again. The rapid expansion of domestic processing facilities is one of the cornerstones of the so-called "New International Economic Order", and while many of the aims of this program have no basis in reality, it should be recognized that there is no reason, at least in theory, why the amount of copper being processed in LDCs in relation to the total quantity being mined could not be increased.

### Forecasting a Copper Price

The major industrial countries seem to have adjusted their thinking to the possibility of a yearly 10 p.c. increase in the price of oil. In adjusting their thinking they are also adjusting their economies, because the result of this kind of price movement is going to be one of the following: a slowing down in the aggregate rate of economic growth or, where this does not take place, a stagnation — and perhaps even a decline — in the standard of living of the elderly, socially and physically disadvantaged, etc. However if the price of oil increases much in excess of 10 p.c., the industrial recovery that is being experienced to one degree or another by many countries will not be sustained. As a result there will be a substantial overcapacity in the world copper industry, and the price of copper should decline to a very low level.

But it is also the case, in the short run, that if the political and military situation in Southern Africa becomes very involved, then the inherent "thinness" of the copper market should work to inflate the price of this mineral. It has been shown on numerous occasions in the past that even very small decreases in current production

are sufficient for speculative forces to drive up the price of copper, particularly during a period when a business cycle upswing is underway or expected. There is no doubt, for instance, that the key factor in the present price rise of copper has been the interruption in supplies from Zambia and Zaire due to the war in Angola, and overcrowded supply routes through Tanzania and Mozambique. In addition, the continuing depreciation of the British pound has made copper less expensive for many consumers, since the price of much of the world's copper is quoted in sterling.

We can now go to the consumption of copper. This increased by 11 p.c. in 1973; declined by 6.3 p.c. in 1974; and by mid 1975 was 22 p.c. lower than a year earlier. As it happened, production did not adjust accordingly, and it was only late in 1975 and early in 1976 that some North American producers began to reduce output. As a result record inventories have been built up that still "overhang" the market and which would, should demand begin to falter, exert an immediate dampening effect on the price. At the present time these inventories amount to at least 1.5 mn tons: three months consumption, or almost eight months of world trade.

The major copper using industries are: The Generation and Distribution of Electric Power (35–40 p.c.); Industrial Machines and Equipment (20–25 p.c.); Building Construction (12–15 p.c.); Communications (10–12 p.c.); Transportation (7–9 p.c.). The heroic assumption will now be made that worldwide all these industries are in the process of recovering from the recession; but at the same time, on the average, none of these will be able to sustain the rates of expansion recorded in the three or four years prior to the October War — at least, not until the world energy picture is clarified, and this cannot possibly take place before 1979–80. Thus, even though a recovery in the demand for copper is to be anticipated, the trend growth rate should decline slightly.

On the other hand, the strengthening of the copper price will probably act as a signal for copper producers in LDCs to resume their planned high rates of expansion. Peru, for instance, plans to double its output of copper in the coming years; and Chile has also expressed interest in bringing about a large increase in production. In addition new producers such as Panama, Iran, and Mexico will be bringing significant amounts of copper to market by about 1980; and Indonesia also has an important production potential. If there is going to be any slowdown in investments it will logically come in North America; but in reviewing ongoing capital expansion in both the US and Canada it appears that capacity is expanding at a rate above

the present trend growth rate of world consumption of 3.3 p.c., and almost in line with the long run historical growth rate of 4.25 p.c.

Two more points are relevant before a price is offered. The first is that about 40 p.c. of world copper production originates in the four original CIPEC countries (Peru, Chile, Zambia, and Zaire). For all practical purposes these countries are passive in the question of pricing. One of the reasons for this is that outside the copper mining sector, productivity in these countries is so low as to leave no choice as to what use available capital and other production factors are to be put: either they produce copper or they are employed on projects with a very low rate of return. In addition, nationalization in these countries has meant that, for political reasons, production must continue regardless of profitability. For instance, in 1975 CIPEC members agreed to reduce copper shipments, and cut production, by up to 15 p.c. Even so, CIPEC production apparently dipped only a few percent, if at all, below the record levels of 1974<sup>4</sup>.

By way of contrast, the concept of a "floor" price needs to be recognized, either implicitly or explicitly, where North American producers are concerned. This is a price, below which some capacity will start going out of operation. Under ordinary circumstances, and in the absence of excessive inventories, an action of this sort would have a tendency to check a fall in price, not only in North America but over the entire world.

On the basis of the above the price, that we are going to interest ourselves in, is this so-called "floor" price. This is because the preceding discussion indicates there will be excess supply in this market for the next few years, at least; and under the circumstances the floor price can be regarded as a kind of equilibrium price. Getting this price is easy. The first step is to establish an average unit cost of production for the period just before the oil price rises of 1973–74. This will be put at 51 cents/pound, and includes a premium to allow for expansion in capacity at the historical rate. I will also take the increase in the global price level, using World Bank figures, as 40 p.c. for the period 1973–74 to 1976–77. The equilibrium price thus becomes  $51 \times 1.4 = 71$  cents/pound. Taking 12 p.c. as a median figure for the rate of return on industrial investments means that this price would have to be about 80 cents to allow for increases in capacity. I would call this the Jan. 1, 1977 price. It should differ from the Jan. 1,

1978 price by a factor calculated from the rate of increase of operating and capital costs between Jan. 1977 and Jan. 1978. In addition, a few cents may have to be added to take into account high cost installations.

A caveat is in order here. The simplicity of the above calculation depended upon the ability, at the present time, to postulate a supply determined market; but should demand unexpectedly reenter the picture in a meaningful way, then a somewhat more extensive calculation involving an unsophisticated simulation model will be necessary (with the emphasis on the word unsophisticated). The reader should also be aware that there is a difference, sometimes a huge difference, between what copper producers want the price of copper to be, and what it should be on the basis of considerations we teach our students in courses on economic theory. For instance, when the price of copper was in the neighborhood of 1.40 \$ per pound, it was sometimes said that the price would have to go to 1.75 \$ for the market to be in "equilibrium". As it turned out, even a price of 58 cents per pound was too high to bring demand back into line with supply.

### Future Prospects

For the last eight years the original CIPEC countries have refused to sit down and discuss the price of copper with the main consuming countries. Recently they changed their position. The reason for this is that they suspect that in the coming years the supply-demand situation will develop in such a way that it will mean a buyers' market for copper. As for the principal consuming countries, despite the well known declaration of Dr Kissinger, in May 1975, that the time had come to regulate the commodity question, they are unable to design a program indicating how these matters will be handled. This would seem to indicate that CIPEC suspicions have a basis in fact.

Interestingly enough, nobody seems to have made a calculation that would tell about how much it would cost for the consuming countries to regulate the copper market in an equitable manner — for example, through compensatory or insurance schemes that provided producers in LDCs with "fair" rates of profit. In the opinion of the present author, schemes could be designed where this cost would be comparatively small. It would not even be surprising if, looked at over a long enough time horizon, arrangements were possible where all parties would gain, at least relative to the present situation. But whether this question can be settled before another crisis blows up, and politicians feel compelled to act, unfortunately remains to be seen.

<sup>4</sup> For more on this matter see F. E. Banks, *The World Copper Market: An Economic Analysis*, Ballinger Publishing Co., Boston 1974. UNCTAD has also proposed a buffer stock scheme for supporting the price of copper. The opinion here is that this is markedly inferior, in all respects, to some others that could be proposed.