

Comments: Bob Ayres, INSEAD, France

I have a number of comments, mainly on copper, but also a few other items.

P.2-10 bottom of first full para. This sentence is wrong. The fraction of copper mined in the US still in use is much smaller, but unknown. See subsequent comment on recovery efficiency.

P.2-10 third full para. There are many other categories of materials that cannot be recycled, in principle, ranging from pigments to solvents to detergents to insecticides. Industrial acids and bases are unrecoverable. Virtually no sulfur is recycled, because most of it is converted into acid.

P.2-11 first full para. This discussion is misleading. Nobody knows the average lifetime or the recovery efficiency for copper. Estimates in the literature range from 30% to 74%. If the 40 year lifetime is correct the recovery efficiency might be fairly high - 70% or so - but if it is only 20 years, the recovery efficiency is very low. N.B even the highest suggested rate of recovery for old scrap is inconsistent with the suggestion that 80-90% of old copper is eventually recycled. (The quoted figure for Sweden is the implication of a calculation, but it is umost unlikely to be correct.) It is true that the main uses of copper in the middle ages, such as roofing and coins were mostly recycled, but other major uses, such as brass cartridges, and bronze propellers on sunken ships are not recovered. The recovery rate today is considerably lower, because so much copper is tied up in small motors, wiring in appliances, and so forth.

Same page, next para. The recovery rate from lead acid batteries is 90%, as stated, but this is also the major use, and the recovery from other uses (such as cable sheathing) can also be quite high. The 55% figure in the same sentence refers to a different measure, namely the fraction of current production that is from secondary sources. The sentence, as written, confuses the issue by implying that the two numbers are comparable. They are not.

P.2-18. The fact that Europe is a larger mineral user than the US is mainly due to the fact that home construction in Europe is largely based on bricks and concrete, whereas North America uses a lot of wood in private housing. Also, European highways are about twice as thick, requiring about twice the amount of sand and gravel. However it is unclear why this is worthy of mention.

P.2-26. It is worth mentioning that the real price of copper has not really been declining on a long term trend since 1920. The trend for coal is definitely up, despite a decline after the mid '80s. This is slightly at odds with the discussion of Barnett & Morse's thesis and the argument for economic definitions of scarcity.

p.4-8 Middle of second para. The sentence starting "But the scarcest elements..." is confusing as written.

Pp.4-8 4-9 Last full paragraph et seq This is thoroughly misleading and divides the world into 'those who believe in the fixed stock paradigm' and those who do not. The four arguments cited on the next page only apply to people who believe that the stocks of resources in the ground are now completely known and that technology is fixed. I know of no such people. Certainly in our copper study we allowed for (gradually) changing recovery technologies, substitution possibilities and improved recycling. That is why we suggested a peak in 50-60 years, rather the 18-28 years implied by Table 4-1. Please fix this!

P.4-9, last para. Note that copper prices haven't been falling since 1920 (although they have fallen sharply in the '90s) as noted above.

P.4-10 second para. The sentence starting "For example, the user costs of mining Swedish ore..." makes no sense as written.

P.5-12 First paragraph of "Copper" section. Power transmission is not one of the essential uses of copper (aluminum is a substitute), nor is telecommunications wire (optical fibers are a substitute.) The essential uses are in motors and electronics, not mentioned in the paragraph. Needs rewriting. I would also say that it the electrification of the economy that has been the key driver of copper consumption.

In the same section I would think it important to note that the main reason for relatively low copper recovery rates for several kinds of consumer and industrial scrap arise from the fact that the copper percentage of total mass is so low. This point is discussed at some length in our report. A further point worth mentioning is the fact that copper cannot be economically recovered from steel. Thus copper contamination is now building up in the global steel (and aluminum) inventory, reducing the value of the steel. This is a problem not only for the copper sector but for the steel recycling sector.

I trust these comments are of some value.