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# Public policy and future mineral supplies

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## ABSTRACT

A widespread and pessimistic view of the availability of mineral commodities calls for strong government initiatives to ensure adequate future supplies. This article provides a more market oriented and optimistic perspective, one that focuses on production costs and prices rather than physical availability. It sees short-run shortages continuing to plague commodity markets in the future as in the past. Though painful while they last, these shortages are temporary and do not pose a serious long-run threat to human welfare. Moreover, even without government intervention, they self-correct. The sharply higher prices that they evoke create strong incentives that foster supply and curb demand.

Potentially more serious are long-run shortages due to mineral depletion. Such shortages are often thought to be inevitable, a conclusion that flows directly from the physical view of depletion. For various reasons, we reject this view of depletion in favor of an economic view. The latter recognizes that depletion may create long-run shortages, but stresses that this need not be the case if new technology can continue to offset the cost-increasing effects of depletion in the future as it has in the past. The economic view also suggests that a list of mineral commodities most threatened by depletion can best be compiled using cumulative availability curves rather than the more common practice of calculating commodity life expectancies based on estimates of available stocks.

## 1. Introduction

A recent issue of *Nature* carries an article entitled 'Mineral supply for sustainable development requires resource governance' by Ali et al. (2017). It paints a rather troubling picture of the availability of copper in particular and other metals and mineral commodities in general over the next half century. The challenges that it highlights are numerous and fall into three broad categories—(1) rapid demand growth caused by rising global population as well as the increased material needs for climate change policies and UN sustainable development goals; (2) constraints on supply arising from inadequate investment in exploration and new capacity, growing community resistance to mining, governance problems in many host countries, long gestation periods for new mines, growing government regulations to protect the environment and for other reasons, and declining amounts of identified mineral resources; and (3) the inability of recycling and secondary production to contribute greatly to mineral commodity supply until the middle of the 21st century, given that much of the copper and other materials currently in buildings and other products will not be available for recycling for some time.

To mitigate and avoid future supply crises, the article recommends the adoption of various public policies, including international targets for global mineral production, common standards to ensure maximum efficiency and minimum environmental damage, support for new extraction technologies, harmonization of best practices, and greater public-private cooperation. Their article concludes with the sentence:

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"Ultimately, international legal mechanisms may be needed to anticipate and respond to future mineral availability constraints".

The authors are scientists and engineers with expertise from across a spectrum of fields. In this respect, their paper reflects an interdisciplinary perspective. It also reflects a widely shared, rather pessimistic outlook on the future availability of mineral commodities and hence the need for strong corrective government measures.[1]

There is, however, a different perspective, strongly supported by historical experience, which many geoscientists, economists, policy analysts, mineral industry executives, and others (including all of us) believe provides a more useful and appropriate framework for assessing the future availability of mineral commodities.[2] It is more market focused and less pessimistic—indeed, it is modestly optimistic about the future. It sees an important role for governments and public policy in ensuring adequate future mineral commodity supplies, a role that overlaps with the policy recommendations of the more pessimistic perspective but one that also diverges in a number of important respects.

## 2. The market-focused and modestly optimistic perspective

Our modestly optimistic perspective concentrates much more on prices and much less on physical availability. What matters for society, this view maintains, is how much we have to give up to obtain an additional barrel of oil or pound of copper. So increasing scarcity and declining availability are defined as either (a) a sharp jump in price over the short run or (b) a persistent increase in real (i.e., inflation-adjusted) price over the long run that slowly but persistently squeezes traditional users out of the market.

This perspective, it is worth noting, does not assume that a peak in production followed by declining output is necessarily an omen of a present or future shortage. Such peaks may simply reflect falling demand.[3] In the early 20th century, for example, the mining of nitrates (saltpeter), used largely in fertilizers and explosives, collapsed thanks to the successful efforts of German chemists to develop synthetic substitutes. Similarly, it was falling demand—largely the result of government regulations motivated by public health concerns—rather than supply constraints, that precipitated the drop in asbestos and mercury production over the past half century.

A case can even be made that the peak in U.S. petroleum production in the early 1970s, so famously predicted by Hubbert (1962), was the result of falling demand for domestic oil as cheaper sources became available from abroad, just as cheaper production from U.S. shale deposits increased the demand for domestic oil and reversed the downward trend during the early 21st century.

The modestly optimistic perspective also makes a clear distinction between short-run or temporary shortages (which rarely last more than a decade and often only a few months or years) and long-run (possibly permanent) shortages. The two are quite different.

Temporary shortages take place with some frequency and for a variety of reasons. Unexpected surges in global demand, inadequate investment in exploration and new capacity, the control of supply by cartels, wars, interruptions in trade, embargos, government fiats, mine accidents, and strikes can all cause severe short-run increases in mineral commodity prices. Recent illustrations include the surge in global commodity demand in the early years of this century due to the rapid growth of the Chinese economy, the fears over export restrictions on rare-earth minerals imposed in 2010 by the same country, and the Indonesian ban on exports of unprocessed ores of nickel and other mineral commodities since 2014.

Such shortages can be quite painful while they last, but they seldom persist for long thanks to what Wellmer and Dalheimer (2012) call the benevolent *feedback control cycle* of mineral supply. Shortages contain the seeds of their own destruction. In response to sharply higher prices, consumers develop and use alternative materials or simply find ways to produce their products with less material input. Simultaneously, higher prices encourage investors to expand existing sources of primary supply, to find and develop new sources, and to increase recycling and secondary production.

Long-run shortages are in almost all respects quite different. They produce rising trends in real prices over many decades, rather than sharp surges for a few months or years. As a result, they pose, at least potentially, a much more serious threat to the well being of the human race. In the past, they have occurred infrequently; so infrequently that it is difficult to identify any such shortages with certainty. The available studies, and there are many, find both downward and level long-run trends. What they do not find are mineral commodities for which real prices have risen significantly over the past 100 to 150 years.[4]

Fig. 1 shows the average annual real prices from 1900 to 2016 for five important metals—aluminum, copper, lead, nickel, and zinc. The prices for these metals are highly volatile over the short run, rising dramatically during economic booms and falling sharply during recessions, but their long-run trends are either downward (aluminum) or more or less flat (copper, lead, nickel, and zinc).

Why do we not find rising long-run trends in real prices? New technologies, discovered deposits, and other innovations have offset, or more than offset, the cost-increasing effects of more stringent government regulations, rising real wages, and especially mineral depletion. If this favorable situation continues in the future, then some mineral commodities will become more available (or less scarce), while the availability of others will remain more or less the same. Of course, it is possible that the discovery of new deposits and innovation will fail to offset the upward pressure on costs from mineral depletion and other forces. In this case, society will have to pay more for its mineral raw materials.

## 3. Policy implications for short-run shortages

The modestly optimistic perspective does recognize that government intervention is needed to correct serious market failures. For the mineral sector, a particularly pervasive market failure arises from what economists call externalities. Externalities occur whenever an activity by an individual or firm creates (a) costs to society that the individual or firm does not pay for or (b) benefits that it does not capture.

Examples of the former are air and water pollution and, of particular concern these days, greenhouse gas emissions. Private firms cannot be expected to curtail their pollution to socially optimal levels unless public policy requires their competitors to do the same. So, clearly, sustainable mineral commodity production requires appropriate environmental regulations.

Similarly, public support is needed for education and for R&D, because the expected benefits to society from these activities far exceed those that the firms, institutions, and individuals responsible for these activities can capture. For the mineral sector, this means that governments have an important role to play in supporting educational and innovative activities from exploration through recycling. For the same reason, public policies are needed to support geologic mapping and other early stages of exploration (Herfindahl and Kneese, 1974; Duke,

[1] Elshkaki et al. (2016), Henckens et al. (2016), and Svedrup and Ragnarsdóttir (2014) are other recent examples of this perspective and provide references to other studies in this genre. Earlier studies include U.S. President's Materials Policy Commission (The Paley Commission) (1952), Gordon et al. (1987), Gordon et al. (2006), and Northey et al. (2014).

[2] Arndt et al. (2017) and chapter 9 of Tilton and Guzmán (2016) provide examples of this view of the future availability of mineral commodities as well as references to other studies with a similar perspective.

[3] According to Wellmer and Scholz (2017), most peaks in mineral production are the result of reductions in demand rather than supply constraints.

[4] Chapter 8 in Radetzki and Wårell (2017) discusses long-run trends in the real prices of mineral commodities and provides references to other relevant studies.