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POLICY BRIEF

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The Metal Bank: A Management Model for Rare Mineral Resources in a Circular Economy

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Highlights

The depletion of "high-grade" mineral deposits has resulted in increasing extractive costs and diminishing economic returns. The market reacts to this situation with either high prices, which depress demand, or sudden drops in prices (such as happened with crude oil in 2014). Such drops reduce or eliminate profits for the mining industry, which in turn is forced to reduce production. As a consequence, it is increasingly difficult to manage the remaining mineral resources in a way that ensures sufficient supply for the economy and avoids price shocks. This is particularly important for rare metals, such as those needed by the electronics manufacturing industry.

A promising long-term strategy to eliminate the depletion problem is to move to a so-called "circular" economy, where all the resources used in manufacturing are completely recycled. One potential solution is stockpiling. The metal bank concept, explained in this policy brief, is a closely controlled stockpiling method that fundamentally follows the principles of circular economy. Metal banks keep rare metals and other similar critical mineral resources stored above ground and readily available to provide a buffer against price and supply shocks.

The Challenge

Commercial mining is traditionally based on mineral deposits of high concentration (also termed "high-grade") that are economically feasible to exploit. However, eventual exhaustion of high-grade resources pushes us to focus on low-grade ones, whose extraction demands more energy and resources. This is the essence of the concept of "depletion", which does not refer to "running out" of something, but rather to diminishing economic returns. Human ingenuity and market factors are often expected to counteract physical depletion, and maintain an increasing supply of mineral commodities. A fundamental component of this expectation is that technological progress can reduce mining costs, even though it may not reverse the depletion process (Bardi 2014). In this light, some have argued that depletion will not affect the capability of the world's economy to keep growing (Barnett and Morse 1963, Houthakker 2002, Bradley 2007).

While most mineral commodities show no evidence of a decrease in production, growth trends have slowed down (Brown et al. 2013). During the past decade or so, the trend in the mineral commodity market shows price increases (Jacks 2013). In addition, the growth of the world's economy is slowing down (Popescu and Nica 2014). A similar slowdown is taking place in world trade (Constantinescu et al. 2015). These observations are consistent with a scenario that projects a decline in the world's economy as a result of increasing costs of mineral production.

Market Trends and Stockpiling

Over the past century or so the mineral resources' market saw constant or diminishing prices and increasing extraction rates. This led to the misconception that mineral resources were extremely abundant, even "infinite". More likely, resources were abundant enough for the short-term planning of most operators, and depletion was not factored in to the exploitation process (Reynolds 1999). However, during the past decade trends have changed. Nowadays, we see increasing commodity prices accompanied by a slowdown in production growth.

One clear example is the fluctuations in the price of crude oil over the past century. Despite some short-term price oscillations, trends in oil prices saw considerable change after the 1970s in comparison to the previous period (Bardi et al. 2016). The prices after 1970 show an unmistakable growth trend, though partially masked by short-term oscillations. This is the result of the increasing costs of extraction generated by depletion. The same trend appears to be true for most mineral commodities since the 1960s. As depicted in Figure 1, all major metallic commodities show strong oscillations superimposed to an average trend of increase. These trends are consistent with increasing production costs, followed by attempts of the market to adapt. Therefore, the management of exhaustible natural resources must move away from a perception of abundance to a perception of scarcity.

A possible strategy against these tendencies is to stockpile resources. In the expectation of supply shocks, resources are accumulated with the intent to sell in times of high demand in order to avoid price excesses and maintain supply. Three such strategies for stockpiling resources are in existence and are briefly introduced here.

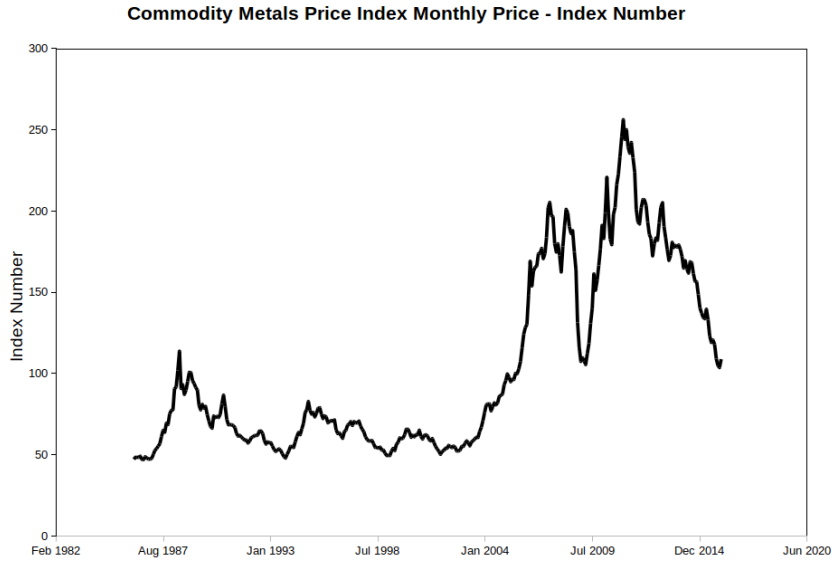

Figure 1: *Metal commodities index according to www.indexmundi.org that includes copper, aluminum, iron ore, tin, nickel, zinc, lead, and uranium. (Data from www.indexmundi.org, accessed 13 March 2016)*

Keeping Resources Underground: Keeping mineral resources underground means that they are not extracted, even though they could be. For instance, when the North Sea oil resources were discovered in the 1970s they were aggressively extracted and marketed at the fastest possible speed, mainly during the 1980s. This happened in a period of low market prices and, it can be argued that, if these resources had been kept underground, they could have been exploited for much higher profits at a later time.

Landfills as Stockpiled Resources: Minerals do not just disappear after they have filled their intended purposes. After going through the industrial/marketing cycle, the minerals we use in various products are finally dispersed in various forms. A larger fraction, in fact, is deposited in landfills as waste. The question is whether landfills can be considered a future strategic supply of minerals. The concept of landfills as the "new mines" or "secondary mines" has been proposed many times (Jones et al. 2012). However, the economic feasibility of the concept is problematic, since landfills are not designed to be mines.

Industrial Stockpiling: Stockpiling after extraction (industrial stockpiling) has advantages. For example, the resource is already processed, refined, and can be marketed faster and at minimal costs. Stockpiling does not depend on the location of mineral extraction. The US Government stockpiles large amount of oil as well as helium in the United States as discussed in a report from the US Department of Defence (DOD 2013). Besides the United States, Japan and China have also been active in stockpiling strategic resources.

The key issue with above ground stockpiling is mainly the cost. This cost, in turn, depends on the physical characteristics of the resource to be stored. Minerals of large volume, such as oil and natural gas, are expensive to stock. The extraction volume of metals is smaller, and it is even smaller in the case of rare metals. Unlike oil and gas, storing of metals does not pose any significant health or safety risks. In this context, rare metals are ideal for stockpiling in a bank, specifically in a "metal bank."

The Metal Bank

The metal bank is an approach that can help overcome the shortcomings of other models of metallic mineral resource management. A metal bank would not just stockpile rare metals, but would actively trade them and manage them to obtain economic profits. Thus, it helps reduce the risk of supply shocks generated by political or economic factors.

Historically, banks have already stockpiled and stored minerals, mainly precious metals such as gold. A bank holding gold reserves is also stockpiling a strategic resource. Of course, it is highly unlikely that a bank would store large

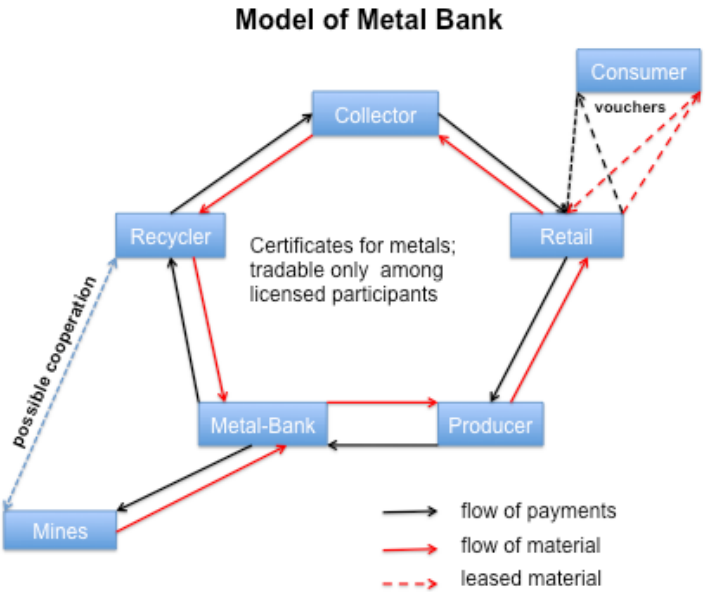

Figure 2: *The Metal Bank Concept. (Bardi et al. 2016)*

amounts of mineral resources such as steel or crude oil in its vaults. It is, however, reasonable to suggest a bank store rare resources that are produced in volumes comparable to those of gold, such as platinum. With a global production of less than 200 tonnes/year, storing a few years' worth of platinum for production in vaults would be easy to do. The same is true for rare metals used in the electronics industry, such as indium, gallium, rare earths, and others.

A schematic of the proposed metal bank is shown in Figure 2. In a nutshell, it is an inter-organisational business with a self-assisting function among the participants. It builds up a physical stock of critical metals through long-term contracts with mines and smelters, as well as with recyclers, in order to increase its physical metal stock. Once the bank has a sufficient stock, it issues certificates that are backed 100% with physical material and can only be traded between producers and users who foresee the need of the material for future use. With these certificates, producers can buy material from the metal bank or trade them among other participants if their needs have changed with time.

In the case of supply interruptions, the bank could release part of its physical reserves to reduce the impact of the shock. Such a bank would likely face short-term economic losses, owing to missed marketing opportunities in case of a sustained period of oversupply. However, these losses could be recovered by the release of the stockpiled resources in times of scarcity and – consequentially – high prices.

The idea of the metal bank involves generating a closed circle among the market participants in order to reduce the influence of speculation. Over time, the bank can accumulate significant stocks of physical resources, usable to dampen extreme price fluctuations from the open market, caused by political or speculative influences. It is a similar model as the one that OPEC is said to practise for crude oil.

Towards a Circular Economy

The metal bank is not just a short-term patch to mitigate the depletion problem. It is, rather, a step in the direction of a circular economy. Such an approach requires more attention to the handling of the material flow than has ever been paid so far. In practice, it requires a change in behaviour of consumers. It is important to reshape consumer behaviour away from possession towards renting and leasing.

There are already some positive examples of such changes in consumer behaviour. One example is the major shift from owning cars to leasing. In this case the consumers pay for the use of a product and its intangible value, and not for the ownership. In the case of a metal bank, a customer would pay for the materials they obtain from the bank; however, these materials would be seen as "on lease". Customers would get a credit to their "metal bank account" when they return the materials to the bank, after the completion of the life cycle of the product. Over a certain period of time enough metals are aggregated to build up a sufficient stock, and ensure supply and price stability. Thus, a metal bank would slowly free the industries from the hands of speculators, who usually do not contribute to the value chain.

The concept of a "metal bank" would be especially interesting for the case of metals used in electronics and the clean energy sector. An example is that of rare earth minerals, commonly used to manufacture computer components, wind turbines, and electric vehicles. The stocks of easily extractable ores for these finite resources are rapidly diminishing. This is gradually forcing manufacturers to develop recycling methods. A few countries, including Japan, have already turned to taking apart items during the waste stream such as old cell phones and old computers to recycle the minerals within them. In the future this may also happen to the hybrid vehicles where the electric motor and the battery contains a few kilograms of rare earth material such as neodymium (1 kg/vehicle) and lanthanum (10-15 kg/vehicle) (Stephenson 2013). For these metals it seems that the classic demand and supply relation for price determination is not valid any more. We have price increases of 1000% and more, defying all rational explanation. This phenomenon may be at work in other sectors of the mineral commodity market. Given the strategic importance of rare earth metals, it is possible that stockpiling them could become attractive in the future. This means developing a "metal bank" concept that will go beyond the simple recycling of used electronic equipment.

Policy Recommendations

Unreliable and unsteady supply of rare minerals and metals can pose a serious challenge to the technological manufacturing businesses that depend on them. While long-term solutions could be achieved via a closed-cycle economy, in the short run the fluctuations and the shortages in the availability of critical metals could be mitigated by stockpiling them. The proposed concept of a metal bank could manage these stockpiled resources and strengthen the development efforts of developing nations, which often serve only as suppliers of raw materials and do not upgrade their own industries in the value chain.

Managing the metallic assets would also mean that the bank will have a dampening influence on irrational price fluctuations in the metal markets. Whether such a bank will be developed in the future remains to be seen, but the unavoidable, gradual depletion of high-grade ores makes such a concept worth investigating already at the present time.

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