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Copper's Crisis and its Reciprocal Impact on Global Politics and Economy

The year 2015 was marked by a series of political and economic troubles and turmoil of all kinds that played out across the globe, and more than ever, we realise that economic difficulties may adversely affect political situations... In the wake of the 2008 global financial crisis, many economies experienced some degree of turbulence and detrimental spillover effects, and conversely, advancements in technology continuously have been threatening to change the global deal. On the one hand, while China in particular is a major copper buyer, the US and the EU are essential players for the valorisation of copper. On the other hand, a significant portion of global supplies comes from South America, with the emergence of a new and increasingly aggressive competition from Asia, Australia and Africa. Eventually, as the third vertex of a triangular game in the global competitive intelligence, technological advancements have made possible substitutions for copper in certain applications.

Through this unstable equilibrium that is continually questioned or challenged, it is hereby proposed to distinguish a competitive intelligence approach, undoubtedly thanks to innovation processes and evolution of societies. Such a triangle leads to three stages of reflection about: 1) the inventory of the copper industry; 2) the game changing disruptions; and 3) the prediction of new horizons.

1. BACKGROUND AND STATE OF THE ART

Given the wide variety of the copper's applications, it is often suggested that the trends in its market are a useful leading indicator of the state of the economy. Because it acts as an effective conductor of heat and electricity, copper is used in the installation, the energy and the ICT sectors, in addition to a wide range of industries, including electrical appliances, electrical engineering, computers, and the transport equipment as well... Automobile production springs to mind it: a passenger car contains about 20-50 kilograms of copper, depending on the model. The construction sector is another major copper consumer, as the metal is used in several ways – on the walls and roofs of building – and as water pipes, and in infrastructure projects – the railway industry, for instance – as well as decoratively in the design of buildings. And finally, copper is also increasingly widely used in the medical sector, because of its strong anti-bacterial properties.

Main Demand Players and Fully Dependent Suppliers

In 1990, the US was the biggest consumer of copper, accounting for 20% of global copper consumption, while China accounted for only 5%. But nowadays, as the world's largest consumer, China accounts for 42% of global copper consumption. The US has the second biggest slice with 9% of the world's consumption, followed by Germany's 6% and Japan which was the second in 1990 and is now the fourth. As the global manufacturing hub, China has overtaken all the other countries as the premier manufacturing location and its demand therefore proves a key driver of global trade in copper.

Copper reserves are highly concentrated. This is unlike other basic metals such as iron ore and bauxite that are dispersed, while Latin America is accounting for almost half of global copper reserves. Chile has the highest reserves, followed by Peru, but Australia has the third biggest reserves of copper. China has the sixth biggest copper reserves, but it is the second largest copper miner behind Chile while Peru holds the third rank, and the United States ranks fourth in terms of copper mine production.

Copper Price as a Leading Indicator

"Dr. Copper" is therefore regarded as a reflection of the global economy's health. The diversified nature of copper's end usage contributes to its bellwether status and then the drop in copper prices can be largely attributed to the global slowdown. The production of copper is capital-intensive and dominated by three components: the price and quality of raw materials, energy costs, and labour costs. The growing dependence on energy across the chain underlines the strong correlation with the oil and electricity prices, since when the oil price rises, energy costs will go up, and the copper price will therefore rise. Normally the US$ rate is inversely related to the copper price, and since copper is traded in US$, a stronger dollar will depress demand for copper as this translates into higher costs in the buyer's currency, and thus adversely affects demand. Conversely, when the dollar weakens

against other currencies, demand for copper used to increase, although a regression analysis on a daily basis shows that there is no long-term correlation between the two. Trends in Chinese GDP growth – that is, at the moment, and consequently the world trade – plays a major role, and it is hardly surprising that economic developments in China are very closely tied to the copper price. By 2015, the stock price index combining construction and farm machinery companies and industrial machinery companies continued its downward spiral and made the largest negative contribution to the net decrease in the leading index. Declining production and other shocks – such as workers' strikes – also have an impact on pure copper prices, despite many analysis show that long-term correlation between Chilean copper ore production and the price of pure copper is less strong. Stock levels do have an impact on the copper price over time, since when stocks are low, the price will be relatively high, and for high stocks, the price will be low.

The copper price also responds strongly to macro-economic figures, which may disrupt the correlation with fundamental factors and may somewhat affect price volatility. In addition, the more intangible factors can have an impact on the copper price over time, because it is also affected by investor sentiment and other intangible factors, such as speculation, the use of copper as collateral issues, etc.

SWOT Analysis and Geostrategic Outlook

A comprehensive approach, by systematic signals' exploration help consider the real state-of-the-art as well as particular zoning rules of the copper in view to anticipate and face challenges head on.

Strengths and advantages
- Copper has a wide range of applications, as it is used in water pipes.
- Skilled workforce, strong supply chain capabilities, with quite good research infrastructures.
- Major copper mines and deposits that are often poly-metallic.
- Copper offers major advantages for new and developing technologies.

Weaknesses and gaps
- Slowing construction industries limit demand.
- Copper is a limited resource and like many metals can be recycled, as an alternative.
- High operating costs, and difficulties in raising capital for exploration and development.
- Environmental constraints due to the international commitment in terms of pollution and climate change are more and more time-consuming, and often lead to an increase in costs.
- Limitations on water and power supplies in remote and deserted regions with difficult access.

Opportunities and enhancements of understated or unexpected results
- Copper reclamation may emerge from the middle class population in emergent countries.
- Copper's natural germicidal and fungicidal effects may expand its uses.
- Replacing stainless steel hospital fixtures with copper could dramatically hamper the spread of antibiotic-resistant "superbugs" such as Methicillin-resistant Staphylococcus aureus (MRSA)...
- Discovery of exceptional new copper deposits, while stepping up production in operating mines.
- Capitalisation on technologies and infrastructure from other industries and research technologies reducing OPEX (Operational expenditure) and CAPEX (Capital expenditure).
- Emergence of technologies to create "clean" ore and meet social and ecological requirements.

Threats and risks
- A lower supply would eventually increase the price as product becomes scarcer.
- Sensitiveness to macro-economic factors such as interest rates and income levels.
- Loss of risk-taking appetite for investors, with uncertainty in future for research funding.
- Impurities unable to be removed at competitive cost at the expense of the price-quality relationship and the best value-for-money.
- Loss of expertise and knowledge with changing economic landscape.
- Substitution of copper by other products and new technologies.

Provision for Historical Comparison
- Products, materials, technologies and technical processes can abruptly turn obsolescent.
- Mistakes of the past should not be traumatic, but should not be forgotten in what would be a culpable carelessness or a guilty recklessness, as regards the history of Salitre in Chile.
- Copper's extractive countries may fear the progressive deterioration of their economy through a creeping deindustrialisation, that is, "Dutch disease."

When creativity and innovation are applied to every aspect of the current business, there are opportunities to stay ahead of a changing marketplace and

enter a new system of competition and a new mode of society. Such a competitive intelligence allows the society to adopt another world vision.

2. PERMANENT ENDANGERMENT F(OR) CREATIVE DESTRUCTION

Joseph Schumpeter (1883-1950), in his work entitled "Capitalism, Socialism and Democracy" (1942), introduced the concept of "creative destruction". It consisted of something new killing something older that denotes a "process of industrial mutation that incessantly revolutionises the economic structure from within, incessantly destroying the old one, incessantly creating a new one." This concept is now firmly entrenched in our minds and does not go forward without sweeping away the preexisting order. Starting from 1997, the work of Christensen should also be regarded as seminal since some companies and countries succeed in exploiting disruptive shifts, while others fall victim to these changes. The key question then is whether the existing policy frameworks with their 'conventional' instruments are adequate to address the implications of disruptive innovation. Because investors face obstacles in betting against stock futures, they have turned to the copper market as they seek avenues to bet on a deepening slowdown in the advanced economies, including China.

Growing Anxiety towards China

In recent years, Chinese investors who used physical metals as collateral for bank loans were credited with driving up demand for copper, zinc and nickel and contributing to higher global prices. Now, the heavy selling of copper futures in China could have skewed prices so much that they no longer accurately reflect the supply and demand for a metal used in everything from iPhones to refrigerators. China's economy is still strong, but its ascendancy can't last forever, and yet China has grows important enough that its domestic vulnerabilities now roil the world at large, about three elements: 1/ China is facing a productivity challenge, particularly for State-owned-enterprises (SOEs); the drop in profits has been larger than the drop in revenue, pointing to a rising cost base; 2/ The industrial capacity has been kept too high; industrial value-added has been growing, and output has held up on average, and using credit to prop the heavy industry up is merely delaying the pain; 3/ China's industrial sector is exporting low prices elsewhere, while local buyers are reaping additional margin from the divergence between producer and consumer prices.

If China chooses the "long-termist" strategy for the 'Rest of the World', this means: (1) no devaluation of the RMB; (2) a major weakness of the Chinese economy in the short term, which will obviously weaken the capacity of exporting toward China; (3) a forward upmarket of China, which will led to a new competition for sophisticated goods, aerospace, IT services... China is a resource-rich country and is not analogous to Japan with its almost total dependence on foreign supplies of oil and gas imports. However, its rapid economic growth, allied with its growing role as the most important site of global manufacturing, has led to increasing demand for externally-sourced oil, gas and minerals so as to meet the exponential growth in domestic demand. As a result, China will be accounting for a major share of both the consumption and production of copper.

When Copper Flops, Suppliers Come Cropper

Recovering and recycling copper for reuse helps meet global demand, conserves natural resources, and improves sustainability by reducing environmental and social externalities. The process of recycling copper uses far less energy – up to 85% less – than mining production. Based on the global copper stocks and flows model recently developed by the Fraunhofer institute, it is estimated that two-thirds of the 550 million metric tonnes of copper produced since 1900, are still in productive use. This copper is largely unavailable for recycling because it is still productively employed in buildings, equipment, generators, ships and other built capital assets. During these past 25 years, the Chilean economy slipped into negative territory only twice – in 1999 and again in 2009 – and after hitting a peak of 45% in 2006, the percentage currently stands at 35%. Although Chile has a stable democracy and macroeconomic stability, it is not trouble-free. Copper used to provide 20% of Chile's GDP and 60% of its exports. Poverty rates had tumbled and public services were mostly improving...
But more recently, the shifts in the copper price made Chile concerned about its future. Towards the end of 2008 during the height of the financial crisis and decline of the housing market, copper struggled more than most metals. Rising copper prices during the middle of the 2000s eventually led to advanced uses of aluminum as a substitute in power cables, electrical equipment and refrigeration tubes. Nevertheless, the major issue is its dependence on copper exports for revenue. The Chilean economy slowed down in 2014, at 1.9%, in part due the end of a commodities super-cycle, which has depressed

prices and cooled investments, and the growth of copper mining supplies at a faster pace than demand.

Beneath and Beyond the Dutch Disease, Risks & Challenges

Comparative advantages work where price is a primary differentiator between the various suppliers of a particular product. Simply put, it refers to a "given" advantage of situation where one country can produce a certain product more efficiently than the other. But in the current global marketplace, more focus is placed on the other components of what is known as differential advantage and, further down the value chain, in the supply of cheap labour sufficiently to make one country attractive to manufacturers. As a country moves up the value chain, in order to retain its comparative advantages, it must continue to seek improved efficiencies, such as a highly-trained workforce. Investment in R&D on technologies will reduce marginal production costs while increasing production volumes and making a significant differentiation, if possible by industrialisation and up-grading in the value chain. The dependent copper's countries should be concerned about the economic volatility that comes with commodity wealth. The question is whether copper could translate into a virtue or a curse.

In economics, the "Dutch disease" is the apparent causal relationship between the increase in the economic development of a specific sector – for example natural resources – and a decline in other sectors, such as manufacturing or agriculture. In the country's exports becoming more expensive for other countries to buy, while imports becoming cheaper, making those sectors less competitive. The term was coined in 1977 by The Economist to describe the decline of the manufacturing sector in the Netherlands after the discovery of the large Groningen natural gas field in 1959, and the subsequent formation of a massive partnership between Esso, Royal Dutch Shell, and the Dutch government in 1963, translated into a substantial decline in the Dutch manufacturing sector. When the copper industry suffers, the entire nation feels the effects, despite efforts towards commodity diversification. In fact, as the copper industry boomed, Chile for example, operating under a system of flexible exchange rates, should have observed an appreciation of the domestic currency due to the influx in foreign exchange. Particularly in medium-income countries such as Chile, it is as difficult to control it – since there is often pressure to spend the boom revenues immediately to alleviate poverty, while ignoring broader macroeconomic implications. As for the extended Dutch disease, economic growth always depends on transfer of labor to sectors with higher value-added per capita, which is impossible since the more sophisticated manufactured goods necessarily use more skilled labor force.

The Salt of the Earth[2] and the Salary of Salitre

By the end of the nineteenth century, the demand for the so-called "Salitre" was beginning to outstrip supply. In 1900, Chile provided two thirds of the nitrogen fertiliser used around the world, and in 1913 Germany bought about one-third of the total Chilean production. Exports of Salitre that reached a maximum of nearly 3 million metric tonnes during WWI, temporarily declined afterwards and then again increased by 1928. Meanwhile, Germany however started producing synthetic nitrogen compounds as soon as 1915, and then surpassed the production of Chilean Salitre in the early 1930s. From 1830 to 1930, the Chilean nitrate deposits were the world's chief source of fixed nitrogen for explosives, fertiliser, and a large variety of chemicals. Within hundred years the Chilean position deteriorated from domination of the world market to a state of not being able to supply the global market for more than one or two years.

In 1913, the Salitre production supplied 54.7% of the world consumption of nitrogen, and by 1923, the figure had gone to 32.2%. By 1950, they accounted for only about 15% of the world market. In the 1990s their share was down to less than 0.1%, but as soon as 1978, only four operating facilities were left, many of the original producing sites and their accompanying living quarters had already become ghost towns. Thus, this Salitre can serve as an excellent example how a chemical technology can arise to create a very large and almost exclusive market, to be sent then almost into oblivion by competing technologies: a discrete invention and technology, the so-called Haber-Bosh process, resulted in the crash of the dream and a serious economic crisis for Chile, practically overnight…

3. REGARDING POSSIBLE FUTURES & EVEN IMPREDICTABLE 'FUTURIBLES'

Raw materials and technology substitutions aim to strongly reduce or totally eliminate the cost connected to the importation while keeping productivity, efficiency and industrial scalability. Companies and copper supplier countries invest in R&D

projects in order to create full mechanisms and develop complete value chains. Some advanced economies are fully mobilised and attempt through private-public partnerships, to boost or revitalise the copper sector, while encouraging a responsible approach of innovation strategy and territorial intelligence. However, there is also, out of the box, many ways to escape an overflow by surprise as it previously occurred for the Chilean Salitre.

Why Demand Players Are Not Looking For Other Products?

Fortunately, as for many applications, at the moment, copper is a difficult material to replace because it performs so well as a power and heat conductor and up to now there was no satisfactory substitute for copper. Large-scale substitutes such as aluminum wiring, Pex plumbing, or optic fiber, claim to be actually more sustainable than copper. But, copper is also 100% recyclable, without any loss in performance, and can therefore be reintroduced again and again into the material cycle. Recycling prolongs the use of the earth's natural resources and saves the energy otherwise consumed to process primary raw materials. There are now many stakeholders in the recycling of *End-of-Life Vehicles* (ELVs): *Original Equipment Manufacturers* (OEMs) design vehicles for production and recycling, dismantlers remove components form ELVs and make parts available for reuse, and forward it to those who process it into raw materials for new vehicles.

Carbon nanotube conductor cables, currently under development, show promise. They have been shown to carry four times as much current as copper wire of the same mass, but at a fraction of the weight. If price-competitive carbon-based nanocomposite products can be produced at a large enough scale, then the demand for copper in power distribution cabling could be reduced. According to a report by BCC Research, *"Global consumption of nanocomposites [was] expected to grow [...] at a Compound Annual Growth Rate (CAGR) of 21.1% for the period of 2014 to 2019."* Thus currently, growth represents the application of nanocomposites to far more than copper replacement applications.

Where Could the Real Danger Come From?

Copper mining has significant social and environmental impacts and risks of mining include displacement of communities, water contamination, and damage to downslope communities from waste rock and tailing. Nevertheless, the catastrophic misadventure of Chile with Salitre – as stated above – seems sufficiently instructive. "Graphene" is a material with an extraordinary combination of physical and chemical properties. Conducting electricity better than copper, stronger than steel, the Graphene's structure is remarkably strong and efficient, even self-repairing – thanks to nano-technology, it is essentially two-dimensional and endowed with unique optical properties. Even though many experts still underestimate its capacity to replace copper, we should not doubt its ability – perhaps in shorter terms we otherwise are expecting, given the dazzling progress made since its discovery. Therefore, it is not absurd to regard Graphene as able to first complementing, and then ultimately replacing copper, for a series of applications. At the moment, the price to and hassle of switching to Graphene need to make sense financially, but the bottom line is that Graphene is too good to be ignored and may yet prove to be too good to be true. The European Commission Vice President Neelie Kroes has announced the "Graphene" flagship initiative, with one billion euro in funding over a period of ten years from the *Future and Emerging Technologies* (FET) scheme as well as national and industrial sources. The "Graphene" flagship initiative is led by Prof. Jari Kinaret, from Sweden's Chalmers University; it involves over 100 research groups, with 136 principal investigators, including four Nobel laureates. Graphene research has long been supported by the Materials Unit of the European Commission's *Directorate for Research and Innovation*. There are at present eight research projects related to Graphene running, and several others are currently being evaluated.

According to Constantinos Markides (2006), early pioneers that create the new products markets are *"very rarely the ones that scale them up from little niches to big, mass markets."* This requires a knowledge of what future markets will demand, while it is rather uneasy, if not impossible, when a potentially disruptive technology, such as Graphene, is still in its infancy.

When You Hear the Bullet, You Have Already Been Hit[3]...

Researchers have been hard at work experimenting with Graphene compounds for batteries that can be scalable, cost-efficient, but most of all, powerful. Researchers also recently found that Graphene mixed with vanadium oxide can create battery cathodes tha t recharge in twenty seconds and

retain more than 90% of their capacity, even after 1,000 cycles of use.

As recently stated (*'Wonder Material' Graphene to push TESLA performance to the next level"*, David Smith), TESLA's critically acclaimed all-electric *Model S* sedan can travel roughly 265 miles on a single charge, according to the EPA, but CEO Elon Musk last month said *"it will be possible to have a 500-mile range car,"* adding *"in fact, we could do it quite soon."* According to China's *Xinghua News Agency and Clean Technica*), TESLA could soon achieve this 500-mile battery thanks to a development in Graphene-based anodes that can reportedly quadruple the density and output of lithium-ion batteries. Actually, it may take years before TESLA can create Graphene-based batteries on a large scale, but if it ever happens, electric car critics would suddenly have little to gripe about. Copper has always been recognised as the preferred material for conducting electricity, which is why it is used universally in motor windings. But Graphene could change and outperform any raw material in this industry. Additionally, the U.S. *Department of Telecommunications and Cable* (DTC) is developing its important transition from *traditional copper based landline telephone service to fiber optic based landline technologies*. Specifically, in the US, Verizon is replacing its traditional copper network in certain communities and migrating customers to a fiber network. Advanced materials ventures are most likely to achieve success if they develop an IP claim on a long-term, emerging market application with major potential. As a matter of fact, not only the big automotive companies are preparing for this disruptive shift, but also new entrants to this market are taking the leadership of this potential revolution, if not a likely announced disaster for the lagging behind industries and territories. A common feature of many disruptive technologies is that their development requires expertise – both in terms of technologies and markets – from different industries. Current forecast methodologies are generally incapable of predicting extreme scenarios, especially those in which the most beneficial or catastrophic events occur. Concepts of 'disruptive technology' describe such competence-destroying discontinuities, and the inertia that prevents incumbents from recognising the potential of an emerging market or a new product feature.

Copper mining companies and, consequently, fully-dependent-copper countries, can't be immune to the emergence of a new sector, that is to say, neither the emergence of new markets, nor disruptive enhancement of substitute products. They therefore can't afford just reactiveness or retro-activeness, but should instead anticipate and constantly monitor the evolution of competition, the advance of new technologies, and then the needs of societies that may occur at any time. Most industries fed by copper components are ripe for disruption, while many more new players – especially start-ups, cash-rich high-tech companies and smart territories – will be likely to empower and literally shape new markets. But, when latecomers and laggards will realise that something occurs and is there, it will be already too late and might be fatal... implacably lethal!

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References

[1]. *Most part of the information and data are hereby derived from the weekly informative watch – free and open to access – of Mr. Jean Grisel (CPU informative watch) on behalf of the Conférence des Présidents d'Université – CPU(France). <https://listes.cpu.fr/sympa-/arc/veillecpu>*

[2]. *Matthew 5-13: "You are the salt of the earth; but if the salt has become tasteless, how can it be made salty again? It is no longer good for anything, except to be thrown out and trampled underfoot by men."*

[3]. *"We all think that we will have time to react when we see it coming. Like a bullet, it hits before it's heard." Mike Elliott, Leader, Ernst & Young, Global Mining & Metals, October 2015*

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