GEM
Gestión y Economía Minera Ltda.

PERSPECTIVE N°12

CRISIS IN THE COPPER MARKET: MACRO NO MICRO

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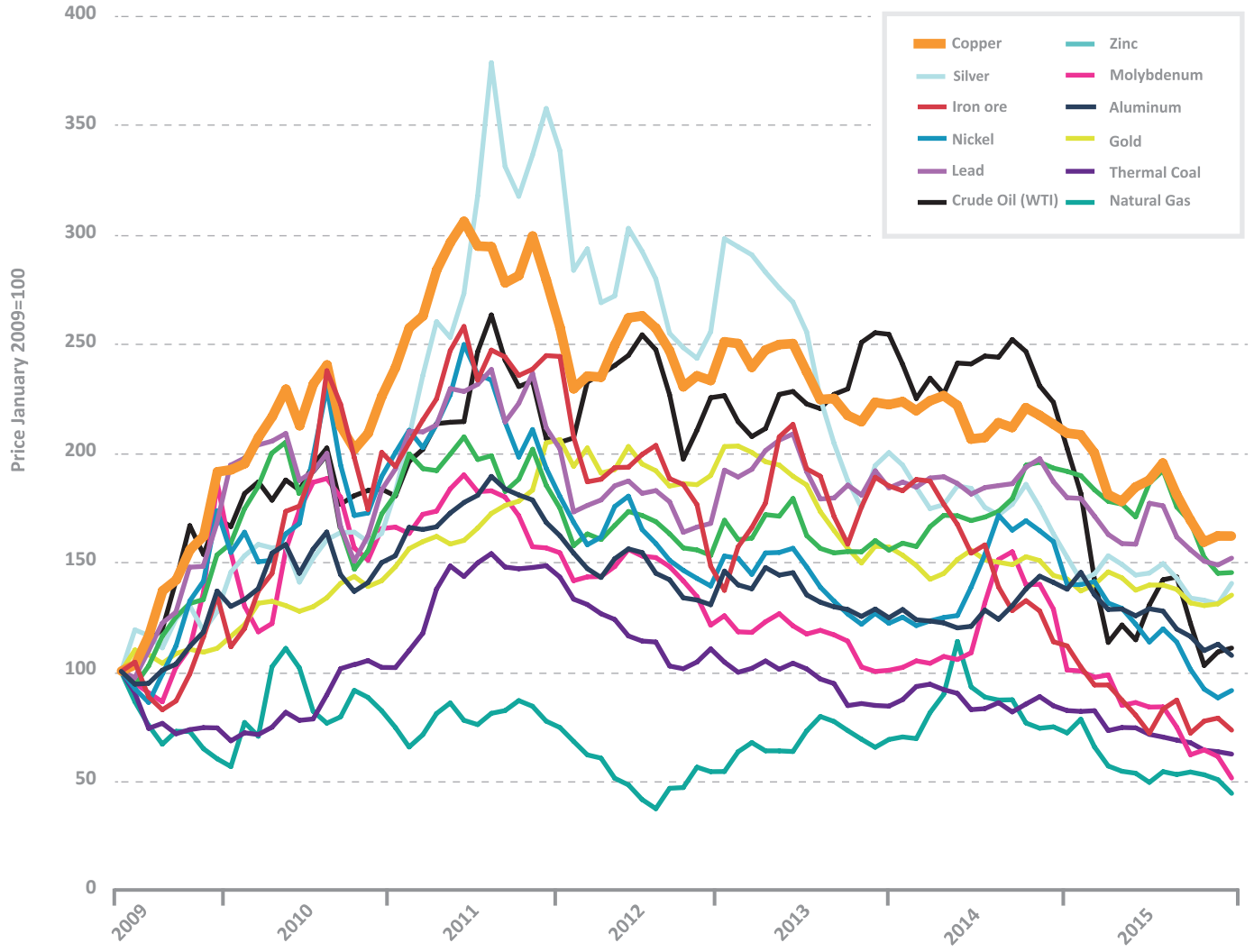
2015: THE YEAR OF THE CRISIS

The prices of mineral commodities, including copper, have shown a downward trend in 2015, reaching levels only comparable, within the last decade, with those observed in 2009 (in the midst of the subprime crisis). In fact, although the copper price has performed better than many other mineral commodities since January 2009, in recent months this gap has narrowed. This is shown in ***FIGURE 1***.

Regarding the copper price from January 2015 to date, it averaged 252.7 cUS$/lb, and unless there would be a significant change in December, the price is likely to finish averaging just slightly lower than 250 cUS$/lb for the year. In nominal terms, this would be the worst annual price since 2009 (where it averaged 234.1 cUS$/lb). However, there is an important difference between the situation of 2015 and 2009 (the year of the subprime crisis peak). In 2009, the copper price was in an upward trend (ending the year with a price over 300 cUS$/lb). Meanwhile, the copper price is expected to reach the end of the year at a significantly lower level (about 200 cUS$/lb), which certainly suggests that next year would not be a year of high prices. At current price levels, some market analysts estimate that about 10% of production in Chile, and a similar percentage worldwide, would not be able to cover their production costs. The latter contrasts with the tough situation for the copper market observed during the subprime crisis where, with a copper price even below 150 cUS$/lb, only about 5% of the copper produced worldwide had a production cost above that price level.

Several market analysts foretell that by the end of 2017 the copper price could again soar above 300 cUS$/lb. Their views are based on structural market reasons such as a copper deficit due to the current project delays and the sustained demand increase, mostly explained by China's continuous growth. This Perspective presents the idea that a market balance analysis based on market's fundamentals is not enough to justify an upward trend in copper price for the short and medium run, and that it is critical to understand production costs to accurately forecast copper price in the short and medium term. Macroeconomics, which largely explains the level of input prices (such as labor or the exchange rate), plays a critical role in order to forecast copper prices in the medium and long run. However, and as it has been discussed in this Perspective, it has proven to be a crucial agent in the copper prices plunge in 2015.

FIGURE 1. EVOLUTION OF DIFFERENT MINERAL COMMODITIES PRICES



Source: The World Bank and London Metal Exchange

Although microeconomic theory seems insufficient to justify the copper price drop during the last year (and considering it does serve to explain an important portion of the price drop seen in several mineral commodities, such as coal and iron ore), macroeconomics have had a key role in the current recession that the copper industry faces. A future copper price recovery will depend, therefore, not only on the market balance between supply and demand, but also on the general levels of prices in the economy, which are strongly influenced by macroeconomic variables.

MICRO VERSUS MACROECONOMICS

Copper price depends on countless variables and expectations regarding their future. As discussed in detail in **Perspectiva N°9 ¿EL FIN DEL SUPERCICLO DEL COBRE?**, copper prices depend particularly on the balance between copper supply and demand. Nevertheless, several factors influence those market elements. For example, while demand is associated with industrial growth or substitutes prices, supply is generally linked to production costs and

certain restrictions that producers might have (Guzmán, 2008; Tilton and Guzmán, 2016).

In order to determine exactly how much of the copper price drop in 2015 could be explained by changes in indicators of supply and demand (microeconomic variables) and changes in the levels of prices in the economy (macroeconomic variables), sophisticated econometric models are required. Although they are beyond the scope of the current Perspective, models made recently by GEM show that the drop in copper price is not only a response to negative shocks associated with future demand (measured through China's manufacturing index PMI or inventories of metal exchanges), but also to structural changes in the price levels in the economy.

The international appreciation of the US Dollar and the drop in the prices of oil, steel and other raw materials are some of the factors that would explain this structural change in the price levels of the world economy. Regarding the price drop of raw materials, it is interesting to note that a plunge in inputs prices lowers production costs for copper producers, which in turn lowers the copper price. The widespread price declines in the economy have cycles that reinforce these contraction trends: a lower price of an industrial commodity creates a downward pressure on all products of the economy, which ends up affecting production costs of industrial products and so on. Therefore, these drops are reflected in lower commodities prices.

GEM has recently studied the copper market from a dynamic system point of view, aiming to determine how the main micro and macroeconomic variables are interrelated. ***FIGURE 2*** shows a conceptual scheme that reflects how the market variables would be interrelated in the short term, based on both the expected theoretical relationships and empirical confirmation of the models developed by GEM.

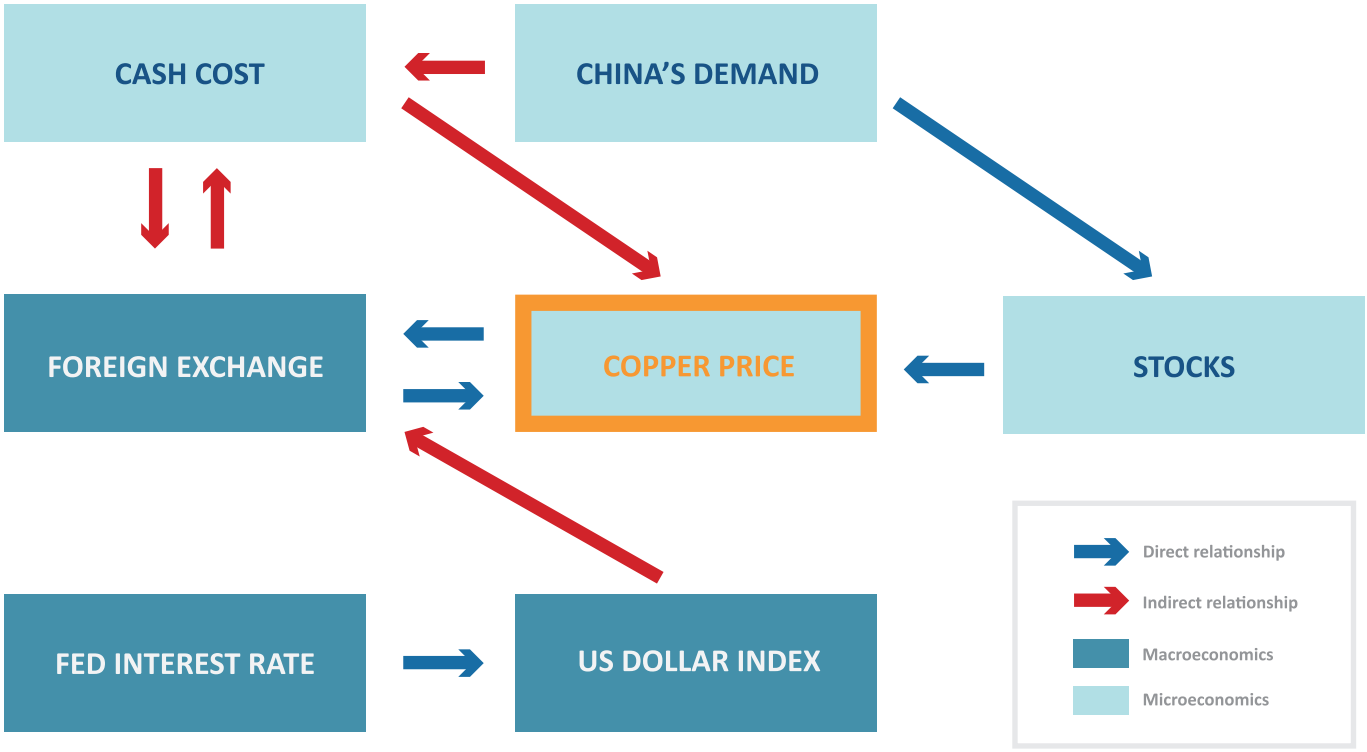
In ***FIGURE 2***, seven explanatory variables are shown. The macroeconomic variables are the foreign exchange rate against the US Dollar for different and important copper-producing countries, the US Dollar Index (which weighs the value of the US currency with the most important currencies of the world), and the Fed's interest rate. The microeconomic variables, those that depend mainly on supply and demand for copper, are the copper cash cost, copper price, manufacturing index of China (a proxy of demand for copper), and inventories in specialized metal stock exchanges (London Metal Exchange, COMEX and Shanghai). The causality relationships are shown with the direction of the arrows, while their color is associated with whether the relationship between the variables is direct (blue) or indirect (red). For example, an increase in production costs moved up the supply curve, which theoretically - *ceteris paribus* - should cause an upward trend in copper price, and therefore the relationship is direct (a positive shock in one variable causes a positive effect in the variables it is linked with). The foreign exchange rate has an indirect relationship with the cash cost, as a positive shock in this variable (that is, the appreciation of the dollar against the local currency) would trigger a reduction in the cash cost, because it would reduce the cost in dollars of all those inputs that are consumed in local currency.

The classic theory of mineral economics states that in the short term the price of mineral commodities is generally explained by demand (for further details, consult Perspectiva N°9 ¿EL FIN DEL SUPERCICLO DEL COBRE? or Tilton and Guzman, 2016). Nevertheless, as it is presented in the conceptual dynamic system displayed in ***FIGURE 2***, changes in production costs and macroeconomic indicators associated with general price levels (dollar) would influence the market price in the short term.

Therefore, the micro and macroeconomic variables interact simultaneously to generate the copper price. GEM estimations based on econometric models reveal variables associated to demand explain no more than 20% of the decline in copper prices in 2015. The remaining 80% or more would precisely be explain through changes in macroeconomic variables associated to the appreciation of the dollar and costs reductions of the copper industry (heavily influenced by reduction of Chilean mining costs).

The classical theory of mineral economics states that in the short run prices of mineral commodities are generally explained by demand. However, changes in production costs and macroeconomic indicators associated to general level of prices (dollar) would also influence the market price in the short run.

FIGURE 2. CONCEPTUAL DYNAMIC SYSTEM FOR COPPER MARKET IN THE SHORT RUN

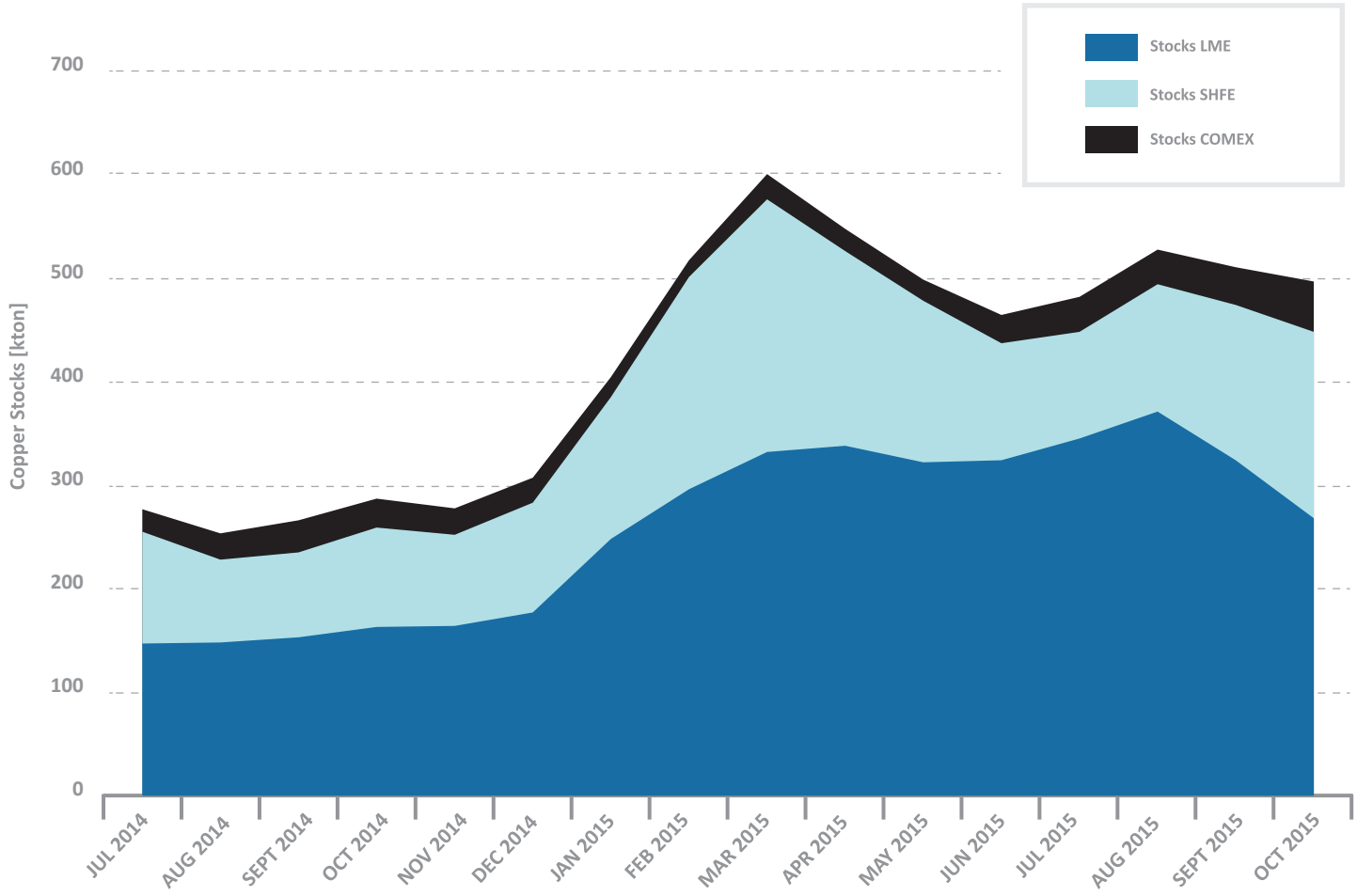


This challenges the traditional view where demand is seen as the determining factor in the definition of copper price in the short term.

Although this is not a formal demonstration, the idea that fluctuations in demand have a minor impact on the copper price drop observed in 2015 can be supported by ***FIGURE 3***. ***FIGURE 3*** presents the evolution of total copper inventory in several specialty metal exchanges (London Metal Exchange, COMEX and Shanghai) since July 2014. As it is clarified in this chart, even though copper prices could have declined due to the accumulation of inventories in the first quarter of 2015 (accumulating around 300,000 extra tons in that period), that is no longer the case since July 2015. Total inventories remained almost constant at about 500,000 tons - varying only 3% in this period. In fact, China's PMI rose by only 1% during this period, and even then the price plummeted more than 12% (about 30 cUS$/lb). Although the costs are not directly observable, the measures taken by the leading companies in the second half of the year are in line with costs-cutting plans. Moreover, the exchange rate of Chile, the largest copper producer, increased almost 8% in that period, while the US Dollar Index increased more than 5%. Then, it is clear that the price levels of the economy and production costs could explain the reduction in the price of copper, instead of the physical balance of copper in the market.

In light of this analysis, is the traditional view of demand as the key factor in the copper short-run pricing process wrong? The answer is not necessarily. Demand appears to be the main variable, in a historical context, responsible for the short-term volatility in copper prices. However, this view has been challenged in 2015 by structural changes in the macroeconomic conditions, which made the copper supply curve and price levels of the economy suffer significant adjustments. It is important to notice that the current context differs of typical market conditions, and that it is crucial to comprehend it in order to understand the challenges and opportunities that the industry would face in the near future.

FIGURE 3. EVOLUTION OF COPPER STOCKS IN METAL EXCHANGES FROM JULY 2014 TO DATE



Source: COCHILCO

According to GEM's estimations the variables associated with demand would explain no more than 20% of the copper price decline in 2015. The remaining 80% or more would be explained by changes in macroeconomics variables.

2016: THE YEAR TO RETHINK STRATEGY

The current situation in the copper market makes it necessary to rethink the strategy followed by mining companies during the last decade, because in the boom period (2003-2012) most companies focused their efforts on producing as much copper as possible, regardless of the cost associated with this production.

Since 2013, and particularly after the sharp fall in copper prices in 2015, the focus on increasing production has become anachronistic. Therefore, since 2013 the companies

have generally refocused their efforts to minimize production costs, sacrificing production if needed. For 2015, a reduction of copper production of about 700,000 tons is estimated just considering the companies' official announcements. This number accounts for a larger amount of copper than the current level of total copper inventory in the main metal exchanges.

Although the elimination of high-cost production is certainly reasonable to address lower copper prices, lower production costs while maintaining the companies' production levels is listed as the biggest challenge of this period. The "easy" reductions (those that could be considered own inefficiencies in the production process) have already been applied by the industry. The remaining reductions are "difficult" reductions, because those are based on optimizations in order to reduce costs.

There is no doubt about the copper price drop as the explanation for the departure of high-cost production and producers. Nevertheless, it forces companies to redefine their development plans. In 2015, a significant number of mining companies began rethinking their future in short, medium and long run scenarios of low prices. Some companies consider that the long-run copper price decrease might account for about 10% less of the value taken into account in 2014. It is important to note that, if projects were not profitable with a long-run price 10% higher, the current scenario becomes even more challenging for the realization of future investments.

Among the changes being analyzed by different companies are those that allow them to keep production without significant investments in expansion projects (brownfield), without sacrificing the chance to grow through investment

In 2015, it is estimated that, just considering the announcements from operating mines, supply reductions would account for 700 thousand tons of fine copper, amount even greater than current copper inventories in metal exchanges.

WHAT IS A DYNAMIC SYSTEM?

A dynamic system is a set of relationships among two or more variables that describe their evolution over time in response to endogenous (system variables) or exogenous (external influence to the system) changes. At each instant of time, the system is in a particular ***state***, which describes the value of system variables. When a certain state is not completely determined by the value of system variables, but receives unknown or random perturbations, the system is called ***stochastic*** dynamic system. The dynamic system of the copper market, as presented in ***FIGURE 2***, is indeed better modeled as a stochastic dynamic system.

Depending on the type of mathematical relationship between the variables of a dynamic system, this could be linear or non-linear. In the first, change in the levels of its variables affects linearly the other system variables. While in the second case, at least one of the system variables is affected by another in a non-linear way. It is well known that in the case of non-linear dynamic systems, small changes in the initial state can generate large and unpredictable fluctuations in future state, a phenomenon known as ***chaos***. Although there are no studies that has empirically validated this, it is likely that the copper market is best modeled as a nonlinear stochastic dynamic system. Therefore, the future is not only random (in essence), but also small changes in variables conditions might have unexpected effects in the future state of the system.

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in the future. The latter because it is estimated that a price upward pressure will appear by the end of 2017 or 2018, and therefore companies might make short-term decisions in order to maximize short-term cash flows, but compromising its long-term value.

In some operations, the need to invest is crucial to continue existing. An exemplary case are those companies exploiting leachable resources that are entering a phase of depletion. The alternative in this case is to continue the operation with non-leachable resources, but in general the required investments are often prohibitive in terms of return of such investments or even in terms of funds availability. GEM has supported several large mining companies in Chile in 2015 that are exploring synergies with other nearby operations (up to 50 km away). The focus has been to find ways to not only reduce investment requirements (many times to half of initial numbers), but also to take advantages of synergies in the availability of strategic resources such as water or energy, and thus reducing risk exposure that the project could have had due to development without these synergies (stand-alone). According to these studies, the synergies associated to the development of joint projects in some cases could increase the value of the business (in NPV terms) between 7% and 25% over the stand-alone case.

Within the strategy rethinking process, it should not be forgotten that the main cause of today's lower copper prices, and possibly in the coming years, is an adjustment in the general price levels of the economy, and not a worsening of the balance between supply and demand. Thus, although the risk that China ends up using less copper in the coming years will always be around, most market analysts agree that China will continue to consume increasing amounts of copper, at least until 2020. Furthermore, supply is expected to stagnate strongly in the next two years due to the almost complete stop of industry projects.

If the copper price begin increasing, the first adjustment in the supply will be given precisely through those producers that have recently cut their offer. The operations that have closed or reduced their production will have the perfect opportunity to reopen its mines and production lines, obviously depending on whether their closing processes were done with enough planning. Only once this rapid response production has entered the market, the need for new projects will be evident. Those companies that would be capable to raise projects in the short run might benefit from the market premium, while non-prepare companies would have to invest a lot of resources and time to develop projects that allow them to grow. This, however, would not allow them to exploit the higher prices context. To take advantage of market opportunities generated by the uncertainty in copper prices is essential to understand the concept of "optionality", and it should be expected for companies to develop qualitatively (and in some cases quantitatively) these concepts in the short run. An example of this optionality is CODELCO's announcement in December 2015, which stated that if the price of copper drops to 1.89 cUS$/lb, some of its smelters could close.

Nonetheless, the industry must be prepared for macroeconomic changes that are unexpected, but not improbable. For example, a significant worsening of the economic situation in the United States could jeopardize the strength of the dollar, which would lead ultimately to a copper price increase. Although China's demand could be considered by many as the greatest risk variable for the copper market, the value of the US Dollar appears to be the variable that could significantly impact the price in the short run, and therefore this variable should be monitored particularly closely by business and market analysts. In other words, unlike the current popular belief that establishes the lowering Chinese growth as the main responsible for the copper price drop seen in 2015, it seems this drop is more closely linked to the outstanding performance of US.

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