Commodities

China - The Engine of a Commodities Super Cycle

Commodity Update

▶ We believe a super cycle is underway, driven by materials intensive economic growth in China.
▶ A super cycle is a prolonged (decades) trend rise in real commodity prices, driven by the urbanization and industrialization of a major economy.
▶ There have been two super cycles in the last 150 years: late 1800s-early 1900s, driving economic growth in the USA; 1945-1975, prompted by post-war reconstruction in Europe and by Japan’s later, massive economic expansion.
▶ High and rising intensity of metals use is the most useful indicator of a super cycle. In China, intensity of use is now three times that of the USA, with demand driven by urbanization, industrialization and fixed capital formation. Importantly, the domestic market drives China’s metals demand, not exports.
▶ In past super cycles, supply has increased to meet higher demand growth.
▶ In the present super cycle, increased supply will come at relatively higher costs. Lead times are also increasing, contributing to extended periods of market tightness.
▶ Under these circumstances, higher long-term commodity prices should be used.
There have been two super cycles in the past 150 years. We believe a third super cycle is underway, driven by China.

Super cycles are...
A super cycle is a prolonged (decade or more) trend rise in real commodity prices, driven by urbanization and industrialization of a major economy.

There have been two super cycles in the past 150 years: from the late 1800s, driven by the USA; and from 1945 to 1975 as a result of post-war reconstruction in Europe, and subsequently by the Japanese economic renaissance.

Super cycles are demand driven
Highly materials intensive economic activity is the cause of super cycles – intensity of metals use in the expanding economy is high, and global growth is moving to a higher trend.

China – the engine of the present super cycle
China accounts for an increasing share of global economic activity (12% of IP, up from 6% in 1995).

It accounts for around 20% of demand for copper and other commodities, and a much larger proportion of demand growth. Intensity of use is 3 times greater than that of the USA.

The drivers are urbanization, industrialization and fixed capital formation. Greatest metals demand exists in China’s domestic market – not its export market.

Supply responses – increased production at higher costs
In past super cycles, expansions in commodity production were not sufficient to offset stronger demand growth.

In the present super cycle, capital and exploration expenditure are increasing but is not expected to result in oversupply.

➢ costs are increasing, and
➢ production lead times are extending.
**Implications for long-term prices**

The higher cost of new supply required to meet demand implies that higher long-term prices are appropriate for project evaluation and discounted cash flow analysis.

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Source: Smith Barney estimates.

**In this report we draw mainly on the copper market**

The copper market has a number of attractions for this type of long-run historical analysis. It is a mature market. Consumption is relatively evenly distributed across geographical regions and a diversity of end uses, and it is correlated with general macroeconomic trends. Market data is relatively easy to obtain.

Preliminary analysis of other commodities shows similar trends and drivers, although some (such as aluminium and nickel) have shorter market histories.
Super Cycles are

Extended periods (decades) of trend rise in real prices...

For the last 30 years commodity prices have been in trend decline in real terms. But when viewed against a longer time period it is evident that this has not always been the case. In particular, commodity prices rose on a trend basis for two extended periods during the last 150 years: from the late 1800s through to the early 1900s; and from 1945 to 1975.

This pattern can be most clearly seen for copper (Figure 2), but most commodities show similar trends (Figure 3).

Figure 2. Copper Super Cycles

Super cycles occurred in the late 1800s–early 1900s (driven by urbanization and industrialization in the USA), and in the late 1940s–early 1970s (driven by post war reconstruction in Europe and Japan, and subsequently the Japanese economic renaissance).

Source: USGS; Platts; US Department of Labor.
It should be noted that in a super cycle, prices rise on a trend basis. There are still business cycles within a super cycle.

**...driven by materials intensive economic growth as major economies urbanize and industrialize.**

The key driver of these super cycles is materials intensive economic growth in major economies as they urbanize and industrialize.

This is reflected by high and rising intensity of use (IOU - the amount of copper consumed per unit of economic activity).
Figure 4 shows intensity of use based on GDP as the economic denominator.

In China, IOU is only just beginning to rise strongly.

In the USA, intensity rose strongly during the early 1900s, then plateaued and declined from around 1940 as its economy evolved. The highly materials intensive growth phase came to an end, as the economy became increasingly services-based.

In Europe, reconstruction post the 1939-45 war boosted intensity of copper use.

In Japan, intensity rose during the early years of its economic renaissance, but declined from 1980.

**Declining intensity & slowing demand bring cycles to an end**

Declining intensity of use brings super cycles to an end as the driving economy evolves from materials intensive infrastructure and manufacturing towards more service based.

We also believe declining demand brings typical business cycles to an end, rather than expanding supply (Figure 5).
Figure 5. Cycles in the Copper Market

Cycles are brought to an end by declining demand. In some cycles (e.g. the mid 1990’s) supply continued to increase, contributing to a prolonged downturn.

Source: Smith Barney estimates.

China’s Contribution to Global Growth

China’s contribution to global growth depends on how you measure it.

China accounts for:

- 4% of global GDP on an exchange rate basis.
- 13% on a purchasing power parity basis, up from 9% in 1995.
- 12% of world industrial production, up from 6% in 1995.

Figure 6. Regional Shares of Global Industrial Production

China accounts for 12% of world IP, up from 6% in 1995.

Interestingly, China accounted for 20-30% of global GDP until the mid 19th century, when it was eclipsed by the USA. Perhaps China is on the way to regaining its past dominance, and perhaps this is the true expression of the super cycle (Figure 7).

**Figure 7. GDP of Key Nations: 0-2004 A.D.**

Source: Maddison (OECD publication); Groningen Growth & Development Cent., University of Groningen; Smith Barney estimates.

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**Super Cycles – Impact on Commodities Demand & the Role of China.**

Figure 4 shows that intensity of use in China has begun to lift sharply.

The contention then is that:

*Further materials intensive economic activity (as measured by rising intensity of use) in China will drive another super cycle.*

Price super cycles are associated with higher levels of trend demand growth. Supply responses are discussed below.
While China’s demand for copper (and commodities in general) has been growing for some years, it virtually exploded in 2000.

In 1999 China accounted for 10% of world consumption. In 2004 it reached 20%.
China now accounts for around 20% of global demand for a broad range of commodities, and an even larger proportion of growth in demand.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>China's share of global consumption</th>
<th>China's contribution to y-o-y consumption growth</th>
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<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>Cement</td>
<td>34%</td>
<td>56%</td>
</tr>
<tr>
<td>Ethylene</td>
<td>6%</td>
<td>6%</td>
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<tr>
<td>Alumina</td>
<td>16%</td>
<td>19%</td>
</tr>
<tr>
<td>Aluminium</td>
<td>16%</td>
<td>19%</td>
</tr>
<tr>
<td>Copper</td>
<td>18%</td>
<td>20%</td>
</tr>
<tr>
<td>Nickel</td>
<td>8%</td>
<td>10%</td>
</tr>
<tr>
<td>Zinc</td>
<td>19%</td>
<td>21%</td>
</tr>
<tr>
<td>Iron ore</td>
<td>26%</td>
<td>29%</td>
</tr>
<tr>
<td>Steel</td>
<td>23%</td>
<td>27%</td>
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<tr>
<td>Gold</td>
<td>6%</td>
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<tr>
<td>Platinum</td>
<td>23%</td>
<td>18%</td>
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<tr>
<td>Pulp</td>
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</tr>
<tr>
<td>Container board</td>
<td>11%</td>
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<tr>
<td>Crude oil</td>
<td>7%</td>
<td>8%</td>
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<tr>
<td>GDP</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Population</td>
<td>21%</td>
<td>21%</td>
</tr>
</tbody>
</table>

Source: Smith Barney estimates.

Some of the dynamics can be seen in Figure 11. (In this data industrial production is the denominator of intensity of use, rather than GDP shown earlier).

Intensity in China has increased sharply since 1999...
And can be compared with the USA in Figure 12.

**Figure 12. USA’s Copper Demand**

![USA’s Copper Demand graph]

Source: WBMS; Smith Barney estimates.

**Drivers of demand – fixed capital formation**

Fixed capital formation is an important driver of metals demand in China. Fixed capital formation has increased to around 40% of GDP. Although there is concern that this may prove unsustainable, we expect fixed capital formation to stabilize at around 50% of GDP, but for the growth rate to slow more rapidly than the broader economy.

**Figure 13. China - Changing Share of Gross Capital Formation in GDP, 1952-2003 (%)**

![Fixed capital formation is increasing as a percentage of GDP. It is expected to stabilize at around 50%]

Source: National Statistics Bureau of China; CEIC Data Company; Smith Barney estimates.
Drivers of demand – urbanization

Urban migration is an important driver of fixed capital formation and super cycles. In China, 10 million people per year are moving from the countryside to the cities, according to World Bank estimates, and this may increase four fold as restrictions on the movement of labour are relaxed as required by the WTO.

Urban migration was also a driver of past super cycles, but fixed capital formation probably did not reach the proportion of GDP seen in China.

Drivers of demand-domestic consumption

At least 50%, and perhaps 75%, of China’s copper demand is for domestic consumption.
Therefore, China’s copper demand is not export driven, nor is a result of a relocation of manufacturing capacity from other countries.

This is also an important characteristic of past super cycles. For example, the super cycle of the 1960s and early 70s faded as Japanese internal development matured, even though exports continued to grow. It is also notable that the boom of the Asian tigers in the early 1990s, which was an essentially export driven phenomenon, did not translate into a super cycle.

### Supply Responses in Super Cycles

Copper mine supply from 1900 is shown in Figure 16.

**Figure 16. Copper mine production since 1900**

![Copper mine production since 1900](source)

Supply increases in super cycles.

Super cycles are not associated with persisting supply deficits.

This is combined with demand to show supply-demand balances in Figure 17.

**Figure 17. Copper Supply-Demand Balance & Price**

![Copper Supply-Demand Balance & Price](source)

Supply increases in super cycles.

Super cycles are not associated with persisting supply deficits.

Source: Metallstatistik; WBMS; Smith Barney estimates.
From an analysis of this data, we conclude that super cycles are not associated with persisting supply shortfalls. Supply typically expands in response to growing demand, but production costs also increase. This supports our view that super cycles are demand driven. We believe this is the outlook for the present super cycle, as discussed below.

Changes in the sources of copper supply since 1900 is illustrated in Figure 18.

The chart highlights how the geographical centre of copper production shifts over time as the economically accessible resources of major mining provinces are depleted. North American production dominated global supply in the first half of the 20th century, eventually giving way to Africa – a major producer in the 1950s and 60s. Latin American has been the pre-eminent copper-producing region since the early 1990s.

There is no known mineral province comparable to that of Latin America that can be developed over the next 5-10 years to deliver new supply at relatively low cost.

**Influence of Technology**

The rapid advancement of technology is sometimes cited as a dampening influence on an emerging super cycle. However, on-going technical innovations have been a long-standing feature of the global mining industry – they are not a recent phenomenon.
While it is difficult to identify new technologies under development, they are likely to have the same impact on the copper market (increasing supply, lowering costs) as did solvent extraction and electro-winning in the 1990s.

The Capital Cycle

Capital spending typically lags the commodity price cycle (Figure 20).

The base load of stay-in-business capital spending is around US$15bn per year, although there are indications that this is increasing. Peaks above this base represent spending on new projects.

The excess capital expenditure of the late 1990s, combined with a slowdown in demand following the Asian crisis, contributed to the subsequent prolonged recession in commodity markets that extended from the mid 1990s until 2004. This pattern reflects that illustrated in Figure 5.

A capital cycle is underway at present. But, increasing production costs mean that higher capital expenditure is likely to translate into a relatively small expansion in production. Furthermore, increasing lead times due to environmental permitting...
and more stringent capital budgeting will delay the expansion of current operations.

Exploration expenditure is also increasing. Again though, long lead times threaten to delay the conversion of these projects into new supply sources (Figure 21).

At this stage, we see no sign of oversupply emerging.

**Figure 21. Worldwide Non-ferrous Exploration Budgets**

![Graph showing worldwide non-ferrous exploration budgets from 1994 to 2004.](source)

Source: Metals Economics Group.

**Production costs and margins**

Data on production costs and margins in past super cycles has proved elusive. However, we surmise that cost increased as production rose to meet demand.

Over the last 25 years or so, production costs have been declining on a trend basis, as have prices (Figure 22).

**Figure 22. Copper Costs, Prices & Margins**

![Graph showing copper costs, prices, and margins from 1980 to 2007.](source)

Source: Brook Hunt; CRU; Smith Barney estimates.
Over the last year, costs have increased sharply – although largely from cyclical factors including fuel prices, consumables and labour.

However, we also believe production costs are likely to continue rising on a structural basis. The additional supply required to meet higher trend demand growth will be higher cost.

Margins are expected to remain constant, and prices will be driven higher.

**Implications for long-term prices**

We believe this environment means that it will be appropriate to adopt higher long-term (equilibrium) prices for project evaluation and discounted cash flow valuations.

Higher trend demand growth will be met by higher cost production. Industry average margins will remain constant. As a consequence, prices will trend higher.

Our approach to deriving long-term prices differs from traditional mineral economics dogma.

Dogma dictates that the equilibrium price is the capital cost of new production, plus a return on the investment. The flaws we see with this are that 1) it ignores the influence of existing production capacity, in which costs are largely depreciated and 2) mining operations rarely return their cost of capital.

Our approach to determining long-term prices is shown schematically in Figure 23.

**Figure 23. Cash Costs vs. Prices – a shift in the curves**

![Graph showing the shift in cost and price curves](chart)

Source: Smith Barney.

Given higher demand growth, the long-term price is a function of costs and margins. If the average cost increases, and margins remain constant, the long-term price will increase.
Implications for trough prices

A further consequence of the super cycle is that as the current business cycle slows, prices will likely decline to a relative trough level set higher than those reported for recent industry downturns (1993, 2001).

![Implications for trough prices](image)

Iron ore – a different market

The history of iron ore costs and margins is starkly different from that of copper. Its industry has seen sustained margin expansion. Persisting tight markets mean that margins will probably be sustained.
### Figure 26. Appropriate Long-term (Equilibrium) Commodity Prices - 2005$

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Source: Smith Barney estimates.
Appendix 1: References

Bloomsbury Mineral Economics (BME), 2005
[Online] Available at: http://www.bloomsburyminerals.com/

CEIC Data Company, 2005
[Online] Available at: http://www.ceicdata.com/

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[Online] Available at: http://www.ggdc.net/index-dseries.html


Metallstatistik (historical commodity production data, 1900-1990), subscription to combined WBMS & CRU research

Metals Economics Group, 2005

National Bureau of Statistics of China, 2005

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U.S. Geological Survey (USGS) 2005

World Bank, 2005

Appendix 2: Historical Price Data Details

**Copper**
- 1897-98, New York price for Lake copper (99.9%-pure copper), in Engineering and Mining Journal.
- 1923-77, U.S. producer electrolytic (99.9%-pure copper) wirebar, in Metals Week.

**Aluminium**
- 1901-04, 99.75%-pure aluminium ingots in 2,000-pound lots, in American Bureau of Metal Statistics.
- 1972, 99.5%-pure unalloyed aluminium ingot, in Engineering & Mining Journal.
- 1973-82, U.S. market spot price, in Metals Week.
- 1999-2004, LME

**Zinc**
- 1905-70, St. Louis/East St. Louis producer price for Prime Western zinc, in American Metal Market/Metal Statistics.
- 1980-93, U.S. Dealers High Grade zinc (99.9% pure) delivered price, in Metals Week.

**Nickel**
- 1850-1912, Price of refined metal, as supplied by Inco Ltd.
- 1980-93, LME cash price for primary Ni (min. 99.80%, cut cathodes, pellets, briquets, 6t lots), Metals Week [through June 14, 1993].
- 1993-2004, LME cash price for primary primary Ni (min. 99.80%, cut cathodes, pellets, briquets, 6t lots), Platt’s Metals Week.

**Steel**
- 1986-2004, Metal Bulletin

Source: USGS.
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