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Metals & Mining (Citi)
Global

■ Equities

Copper vs. Steel

Demand & Price Implications In A Consumer Driven China

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- **China in Transition** — Our economists argue that China is on the cusp of an imminent rebalance towards consumer-led growth. Indeed investment to GDP which peaked at a record 49.7% in 2011 has begun to roll over, falling to 47.5% in 2012. Such a rebalance is clearly negative for early cycle commodities such as steel and iron ore, while copper should be relatively resilient due to its late cycle demand profile. In this note we quantify the impact of this transition on demand and prices.

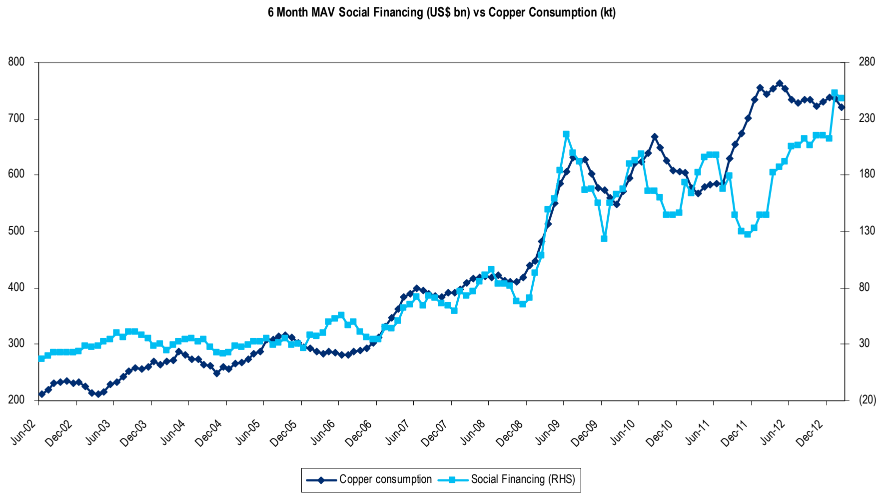
- **Credit could be key** — Declining returns are likely to force capital away from investment and towards consumption. Between 2008-2012 total social financing, the broadest measure of credit extension, accelerated from 130% of GDP to 186%. Profitability of investment has been sacrificed as excess credit has had to chase lower returns. The ratio of credit required to generate a unit of GDP averaged 2.4x in 2009-2011, up 71% on pre-crisis levels. Unsurprisingly, the credit to commodity relationship is strong as the lion's share of investment went into infrastructure spend. Copper and iron ore display a strong relationship with credit growth with R^2 of 65% and 67% respectively. The declining efficiency of credit is reflected in the increasing amount of funding required to drive a tonne of consumption which has risen 2x since 2008; from $167k/t to $339k/t for copper and $1,738/t to $3,350/t for steel.

- **Impact on Commodity Markets** — Using a range of scenarios based on % of GDP spend and urbanisation trends seen in the development of other countries, we conclude that by 2020 copper consumption in China could actually be up to 20-35% lower than consensus expectations of ~12.7mt at 8-10mt, while steel fares worse with up to 30-55% downside vs. consensus expectations of >1bn tonnes at 450-700mt. Based on our cost curve analysis this would reduce the long term price of iron ore to $55/t (real) and copper to $5,000/t (real). This compares to consensus long term prices of ~$80/t iron ore and $7,000/t copper suggesting ~31% downside to iron ore forecasts and 29% downside to copper price forecasts

- **What are equities pricing in?** — One could argue that the bearish iron ore story is now well told and priced in to equities, while in copper the market continues to maintain faith in the concept of limited supply growth. However, we calculate that the UK iron ore equities are pricing in $90/t long term and copper $7,100/t, suggesting ~40% downside to iron ore equities and 30% to copper. This suggests that the potential scale of the decline in iron ore demand has still not been fully appreciated, while the downside in copper is also not reflected in the market's perception of the equities.

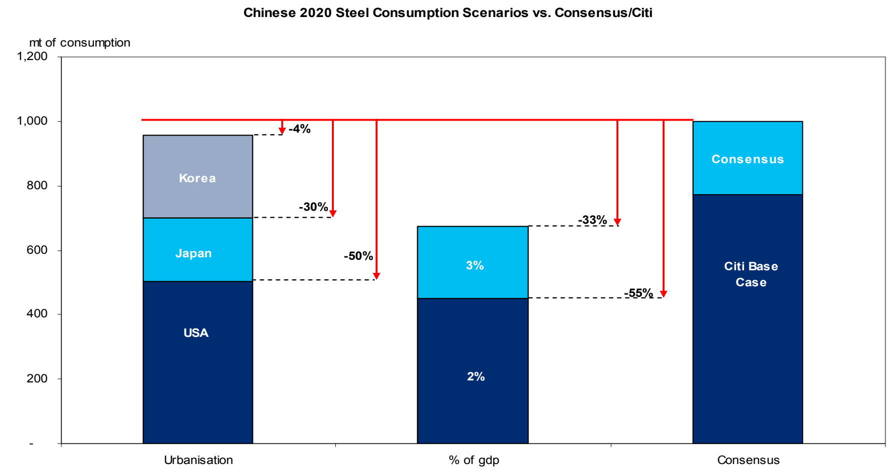
See Appendix A-1 for Analyst Certification, Important Disclosures and non-US research analyst disclosures.

Figure 1. Copper and steel have been key beneficiaries of excess credit with an R^2 of 65% and 67% to Total Social Financing. In a rebalance credit will be directed towards consumer spending



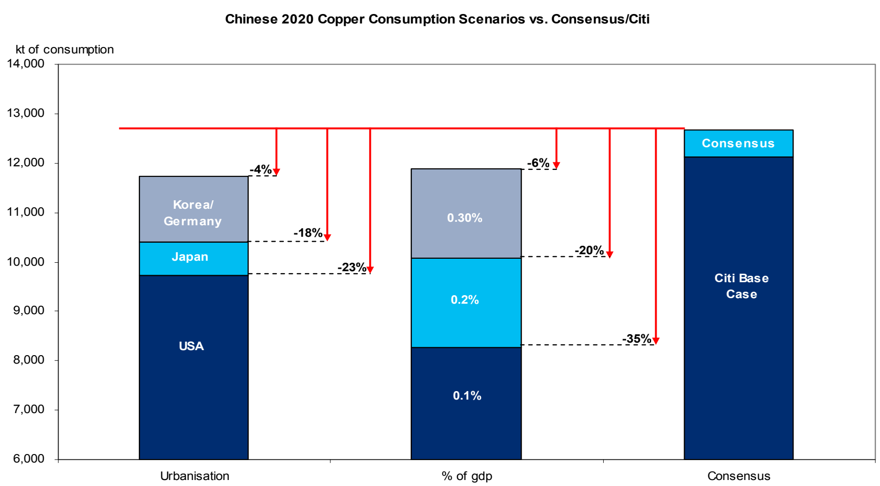
Source: Citi Research

Figure 2. Our analysis of urbanisation and GDP suggests steel demand could miss consensus forecasts of >1bt by 4-55% with the most likely scenario 30-50% below



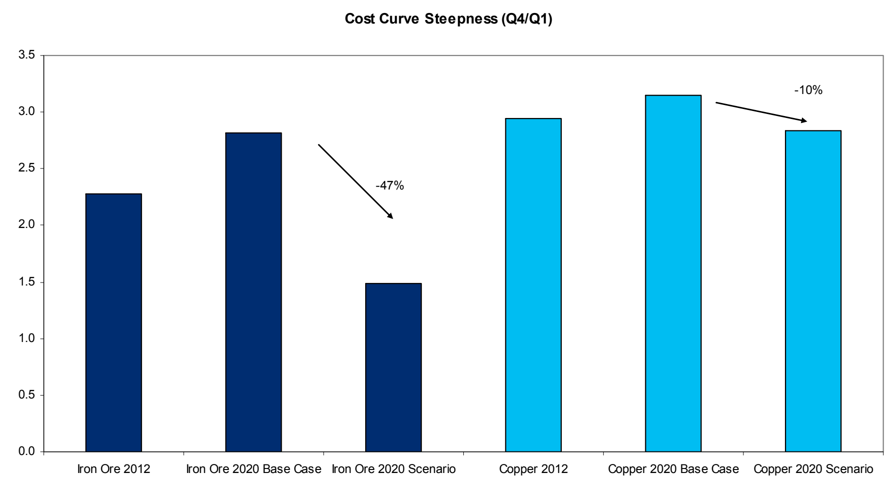
Source: Citi Research

Figure 3. In copper the shortfall is less but still significant with the most likely outcome18-20%



Source: Citi Research

Figure 4. The cost curve could flatten for both metals, steepness is correlated to ROCE



Source: Citi Research

The shift to a consumer based economy is imminent

- Our economists argue that China is on the cusp of an imminent rebalancing towards consumer-led growth (Citi GPS: China is about to rebalance. How will EM be affected?, July 2012)

- The pace of China's spending on investment drove investment to GDP ratios to a peak of 49.7% in 2011. Relative to peaks in other nations the ratio looks extremely stretched (Figure 5) being 8ppts above the next highest and 14ppts above Japan.

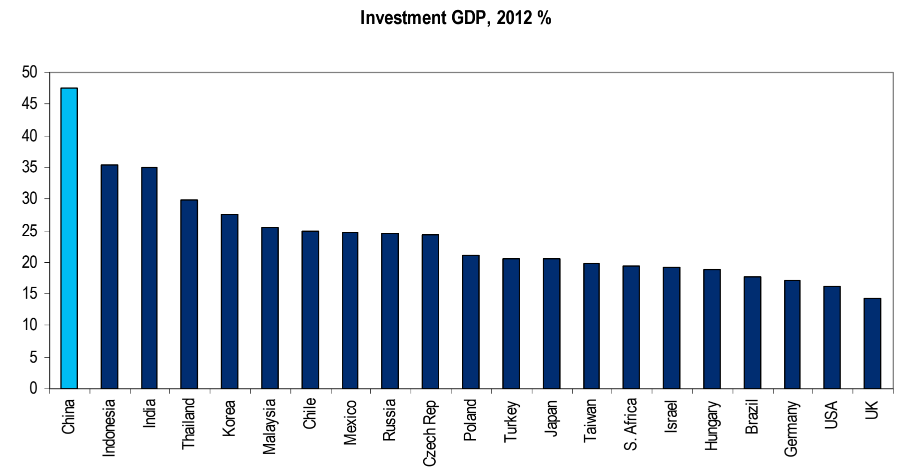
- Already in 2012 the reversal of this trend is beginning to become apparent (Figure 7). This is still early days however, China's investment spend in 2012 was still over 10ppts higher than the next closest country.

Figure 5. China's investment to consumption ratio is highly stretched relative to peer and history

	China	Japan	US	Korea	Taiwan	Thailand	Indonesia	India
Investment/GDP ratio								
2011	49.7	19.9	15.9	29.5	21.1	26.6	32.7	35.7
Historical peak		36.4	23.2	38	30.9	41.6	32.2	35.8
Year of historical peak	2011 (so far)	1973	1943	1991	1975	1991	2010	2007
Consumption/GDP								
2011								
Historical trough		52.3	49.5	49.1	47.2	53.2	56.7	61.7
Year	2011	1970	1944	1988	1986	1995	2010	2009

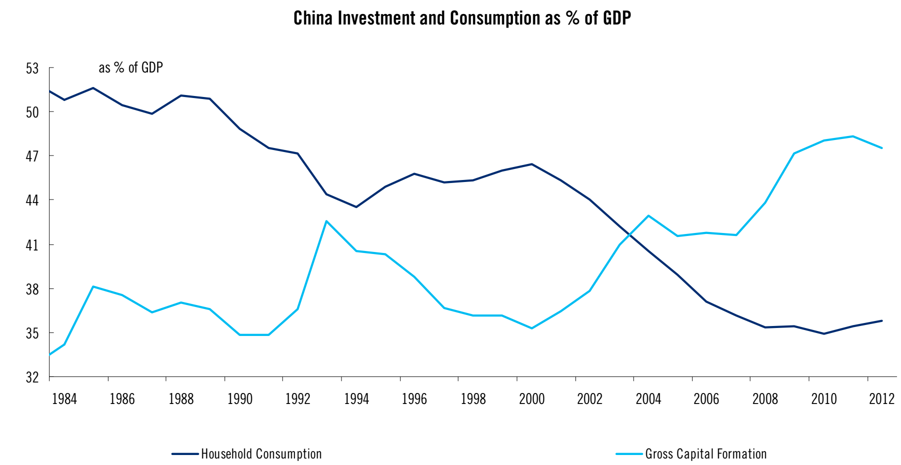
Source: Adapted from Fukumoto and Muto (2011), Citi Research

Figure 6. Which has produced an outcome where China invests more than any country globally



Source: Haver Analytics, Citi Research

Figure 7. 2012 could represent the turning point in growth of investment over consumption

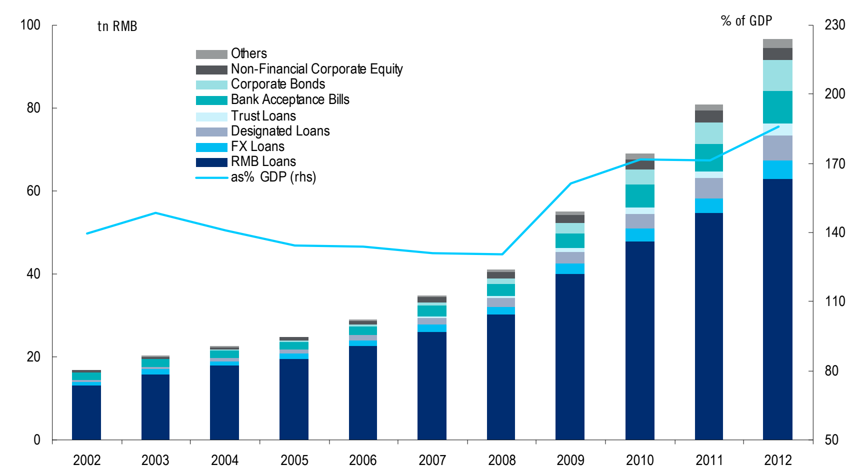


Source: Citi Research, Fukumoto and Muto (2011)

Driven by declining return on capital and credit

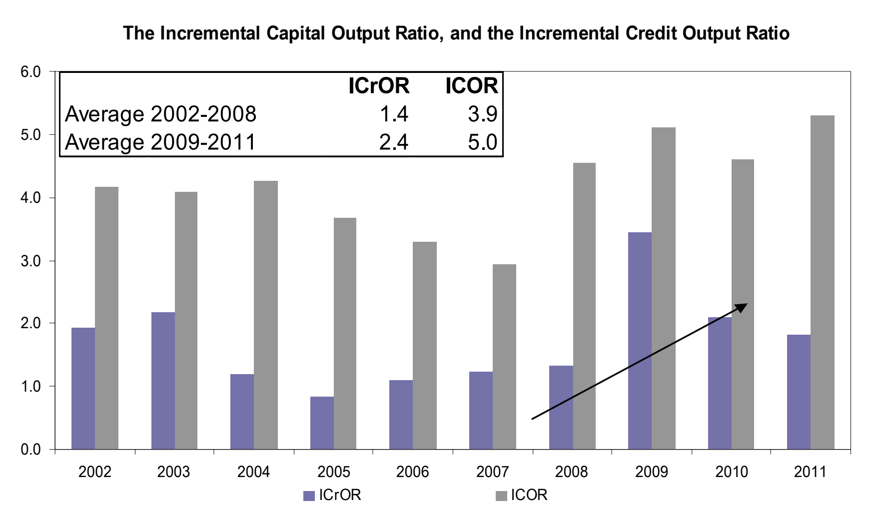
- The increasing credit-dependence of the Chinese economy has arguably sown the seeds for future rebalancing. The scale of the post Lehman credit stimulus is evident from Figure 8. In the 4 years from 2008-2012 total social financing, China's broadest measure of credit extension, accelerated from 130% of GDP to 186%.
- This surge in lending has inevitably sacrificed the profitability of investment as excess supply of credit has forced capital to chase lower returns. This diminishing efficiency of capital is shown by the rise in the Incremental Credit Output Ratio (ICrOR, Figure 9) which represents the amount of credit needed to generate a unit of GDP. This averaged 2.4x 2009-2011, 71% up on 2002-2008.
- **A rebalancing of the Chinese economy is ultimately likely to be driven by decreasing marginal returns on each investment unit (Figure 10) forcing capital away from investment and towards consumption. In addition active policymaking is likely to accelerate this process, in our view.**

Figure 8. The stock of total social financing has risen 2.4x since 2008 to 180% of GDP



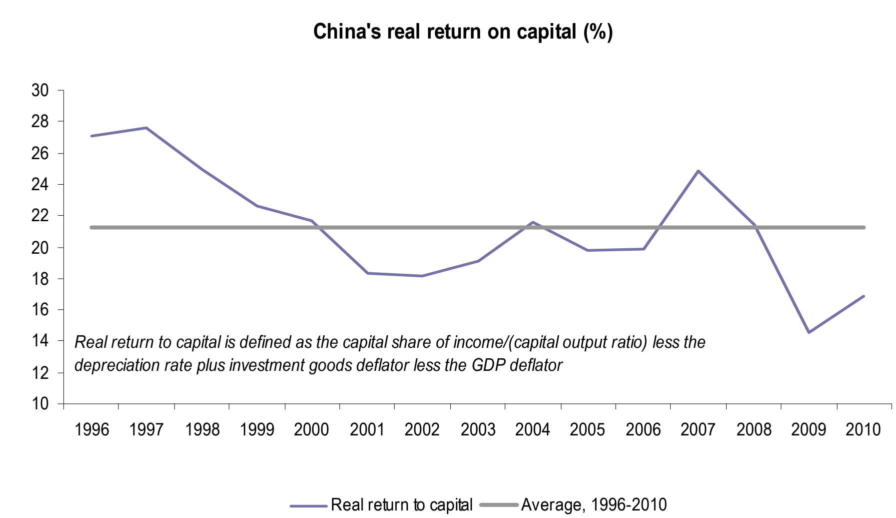
Source: PBOC, Citi Research

Figure 9. Investment efficiency has fallen amidst a rise in credit dependence



Source: Citi Research, ICOR is the investment/GDP ratio divided by GDP growth; ICrOR is the credit/GDP ratio divided by GDP growth

Figure 10. …pushing down the return on capital deployed in the Chinese economy

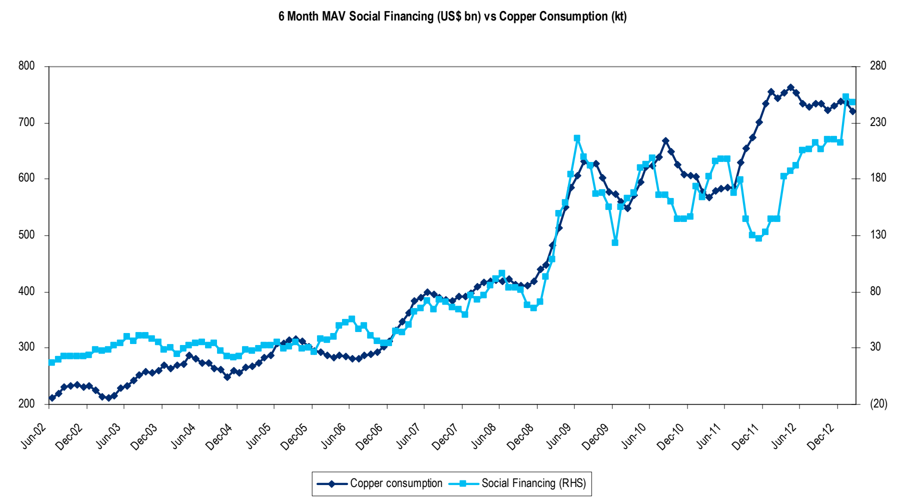


Source: NBS, Citi Research

Credit fuelled commodities: copper and steel closely correlated to lending

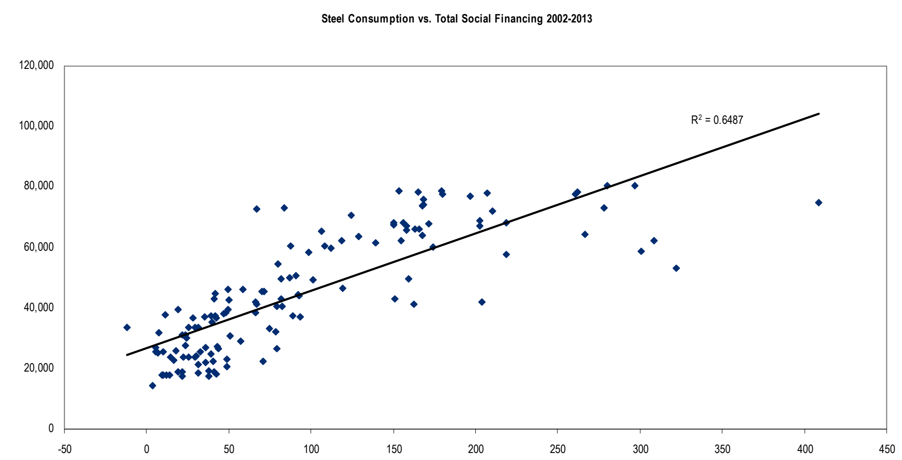
- Both copper and steel, along with other hard assets, have been key beneficiaries of excess credit as the lion's share of lending has been funneled into infrastructure spending. Freely available credit has also fueled the collateralised financing trade. Readily stored commodities such as copper and steel can be imported on margin, collateralised and the money re-lent with the importer capturing the interest spread.
- This relationship is evident from Figure 11 which shows how copper consumption growth has mirrored the acceleration in social financing
- **The correlation of both copper and steel with funding appears to be strong with R squared of 67% and 65% respectively.**
- Diminishing investment returns are also reflected in the declining purchasing power of social funding. **The amount of credit required to drive a tonne of consumption for both copper and steel has risen 2x since 2008: from $167,000/t to $339,000/t for copper and $1,738/t to $3,350/t for steel.**

Figure 11. There appears to be a strong relationship between credit issuance and copper consumption



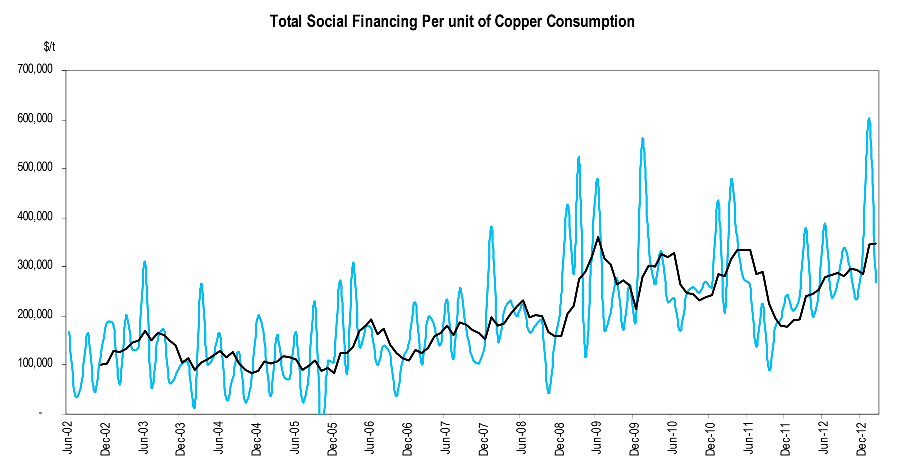
Source: PBOC, Bloomberg, Citi Research

Figure 12. Both copper (67% R^2) and steel (65% R^2)have a high correlation with social financing



Source: PBOC, Bloomberg, Citi Research

Figure 13. The amount of credit per tonne of copper consumption has risen 80% since 2008

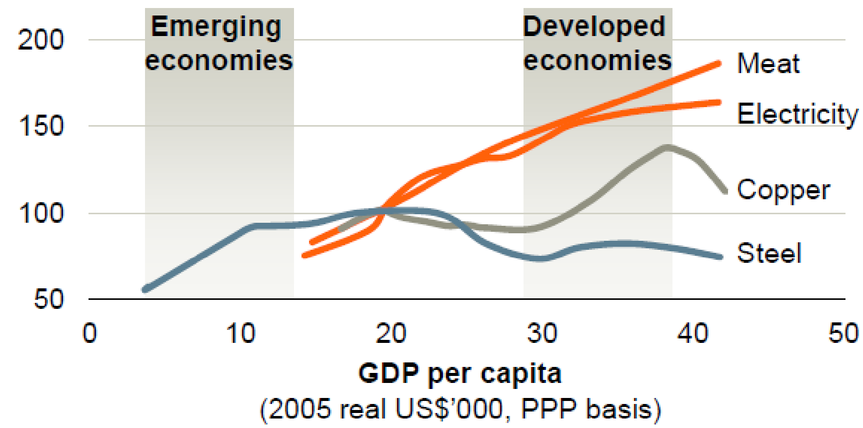


Source: PBOC, Bloomberg, Citi Research

Handing the baton: investment gives way

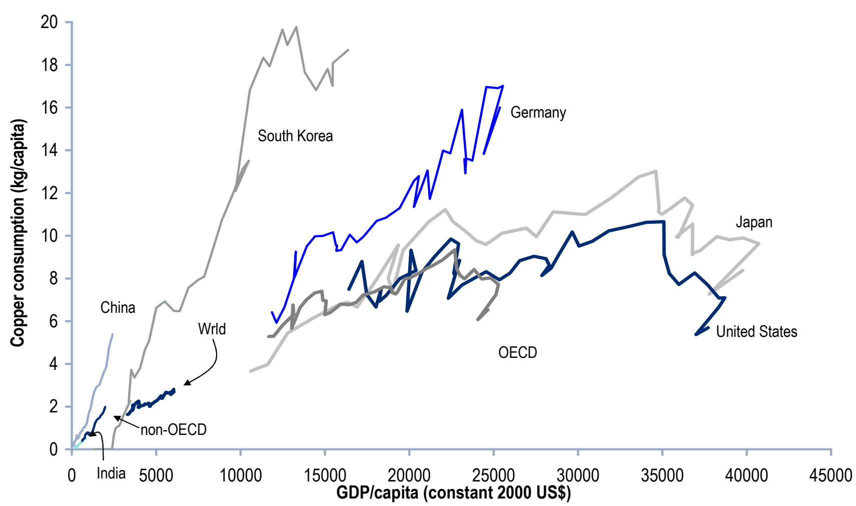
- Under a transition the flow of credit is likely to be directed towards consumers and therefore the demand for consumer related products. Copper's through-cycle demand profile (Figure 14), benefitting initially from early cycle sectors including construction and later from consumer-driven expenditure on autos and white goods, **suggests less vulnerability to this shift than steel.**
- The question then becomes 'where to from here?'. The transition of China is likely to have wide ranging ramifications for both copper and steel. China is the dominant global market for both commodities with a market share of consumption of 41-47%.
- Traditional per capita analysis (Figure 15 and Figure 16) appears to suggest that China has room to grow demand for both steel and copper.

Figure 14. Copper is a later cycle commodity than steel as shown by the US intensity index



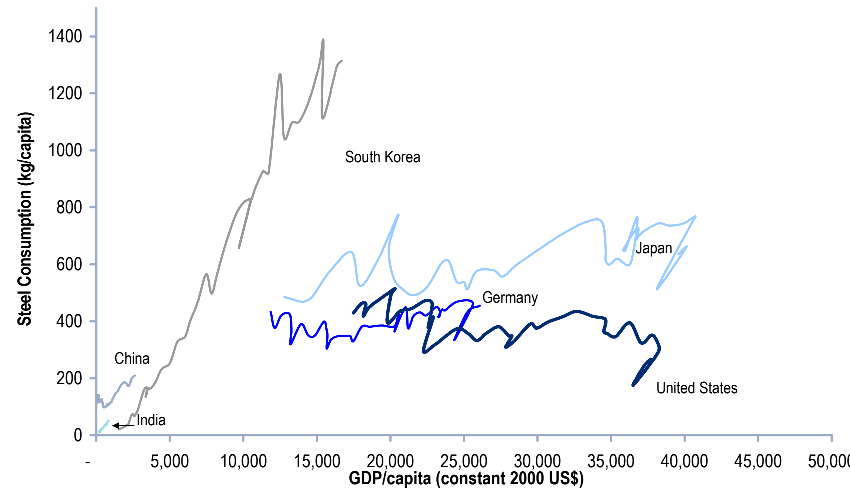
Source: BHP Reports, World Bank, CRU, IISI, CISA, Global Insight, World Steel Association, JBS, IEA

Figure 15. Copper consumption per capita appears to have significant growth headroom…



Source: Wood Mackenzie, World Bank, IMF, Citi Research

Figure 16. …as does steel



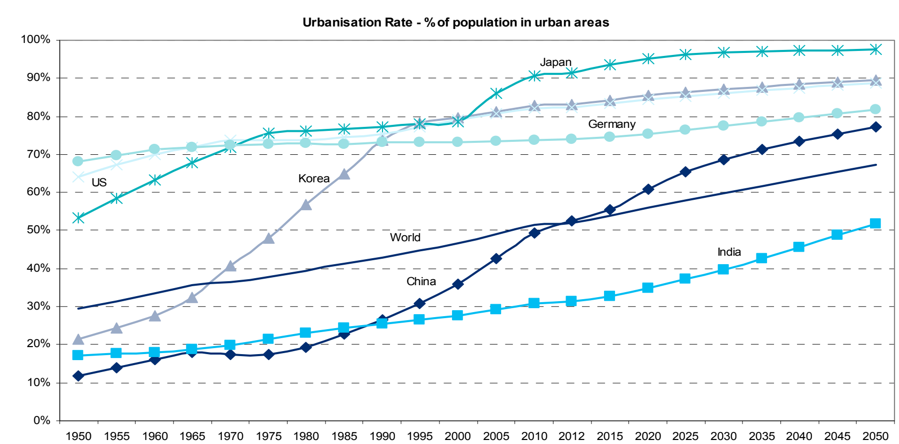
Source: CRU, World Steel, World Bank, IMF, Citi Research

Method 1: Urbanisation support showing signs of slowing

- However in our **view per capita analysis is flawed when it comes to determining future demand**. It implies that a) people living in Xinjiang will have the same intensity of use as those in Shanghai and b) end user demand is insensitive to price.
- As a result we have taken two approaches to reaching a top-down assessment of the underlying demand potential in China **1)** urbanisation analysis **2)** maintenance demand as a % of GDP
- Urbanisation should represent the true, underlying demand picture of an economy having as it does a 0.85 correlation with GDP per capita[1]
- It provides a fundamental control factor to compare economies and therefore the demand for commodity inputs. Increasing wealth generates demand for late cycle products including white goods and autos while also boosting demand for infrastructure related investment such as power and residential construction.
- Controlling for the overall rate of urbanisation should also limit the specific bias in analysing China data created by the accelerated development of the east coast
- Based on UN data China's 2010 urbanisation rate was 49% with recent NBS numbers placing the 2012 figure at 53%. Despite an acceleration in urbanisation from the 1980s onwards these levels remain significantly below more developed countries at 70-90% (Figure 17). While the Chinese urban population is expected to continue to increase to 77% in 2050, the rate of increase appears now to have peaked (Figure 18).

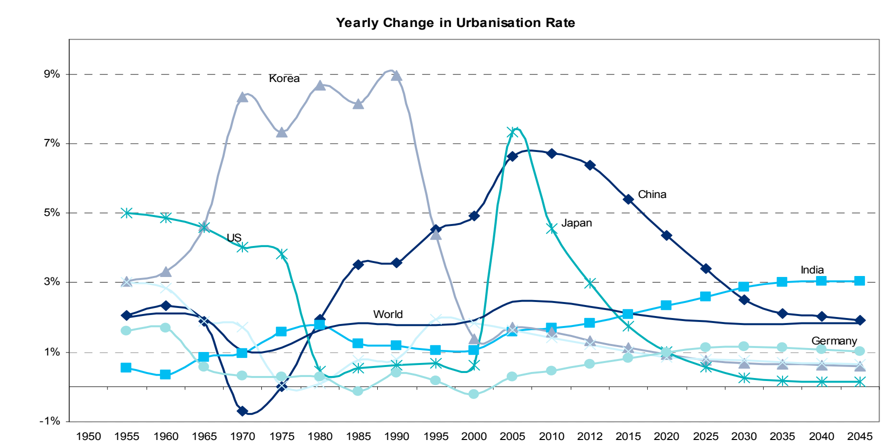
1. Henderson (2003)

Figure 17. China was 53% urbanised in 2012, up from 36% in 2000



Source: Citi Research, United Nations, 2015-2050 UN forecasts

Figure 18. The rate of growth in urbanisation has however peaked

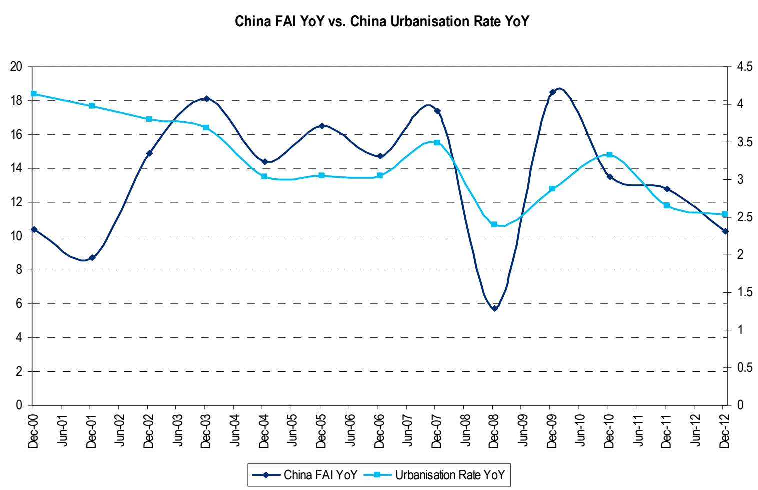


Source: Citi Research, United Nations, 2015-2050 UN forecasts

Urbanisation intensity more supportive for copper

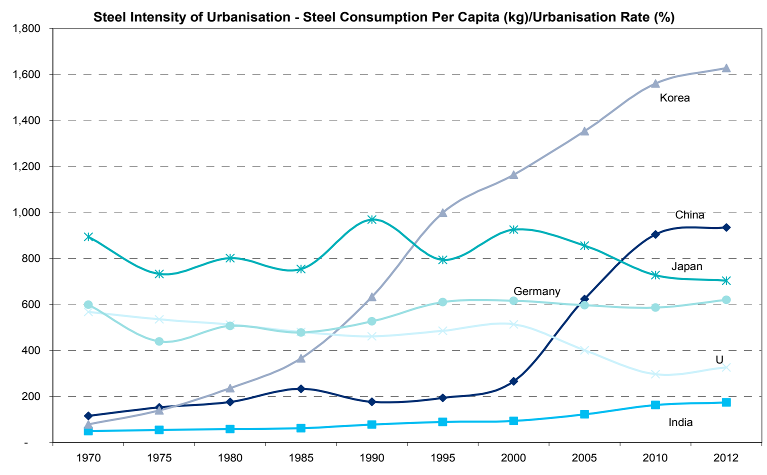
- There is an intuitive link between the amount of copper and steel consumed and the number of people living and working in urban areas. As a result the copper or steel 'intensity of urbanisation'; the ratio of copper or steel consumption to the urbanised populace should provide an indication of the sustainability of China's current demand levels.
- **Both copper and steel intensity ratios have accelerated rapidly since 2000 with copper rising 3x (Figure 21) and steel 4x (Figure 20)**
- The trend in copper is not unprecedented with a number of nations seeing rapid growth over the past 50 years: Japan's growth through the post-war 'economic miracle' years saw its copper intensity expand 3x from1965 to 1990.
- In steel only Korea has shown a similar level of growth. As you would expect for a mature industry the ratios in established nations have remained relatively constant.

Figure 19. Growth in FAI and therefore materials demand has far outstripped urbanisation growth



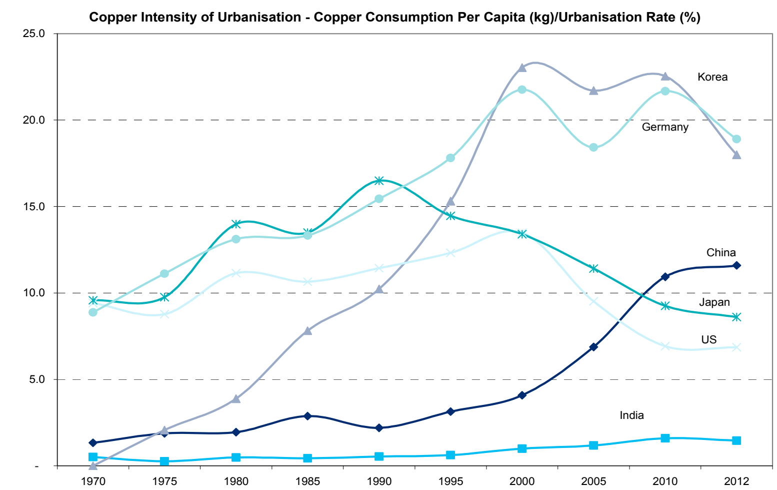
Source: Citi Research, Bloomberg

Figure 20. Driving China's consumption/urbanisation ratio for steel past Japan, US and Germany



Source: World Steel, CRU, United Nations, Citi Research

Figure 21. The copper ratio has surged 3x since 2000 but remains below the peak in other nation



Source: Wood Mackenzie, United Nations, Citi Research

The path of future demand

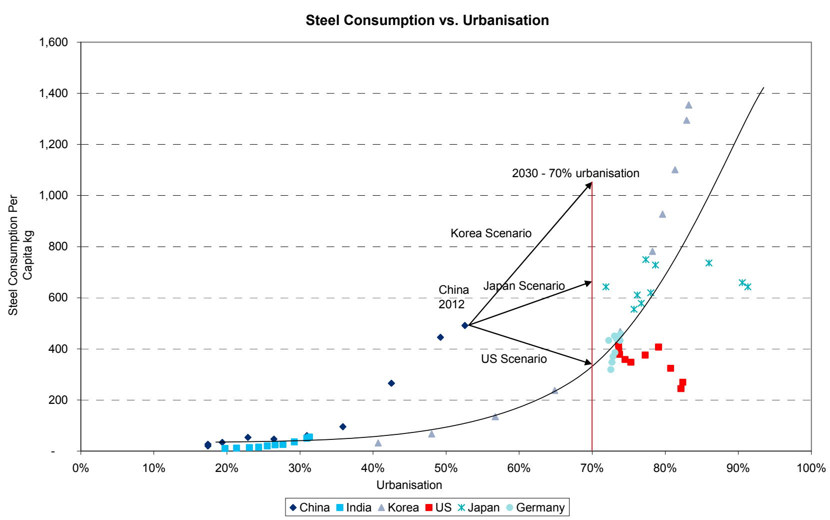
Steel

- Given data limitations and the early cycle nature of steel demand we do not have consumption for the periods when other nations (bar Korea) industrialised. However normalising for current intensity rates can still provide a powerful indication of future demand, in our view.
- We have run three scenarios based on an expected Chinese population of 1.4bn and the normalisation of the steel intensity ratio by 2030 to levels similar to **1)** the US **2)** Japan **3)** Korea
- **China is consuming well above trend**. A decline in intensity levels to those of the US would return the relationship with urbanisation to historical trend levels. Sustaining current intensity levels, similar to Japan, implies a reduction in the rate of growth of steel consumption, but still growth. Korean intensity levels would require China to maintain the same steel demand growth rate as the super cycle.

Copper

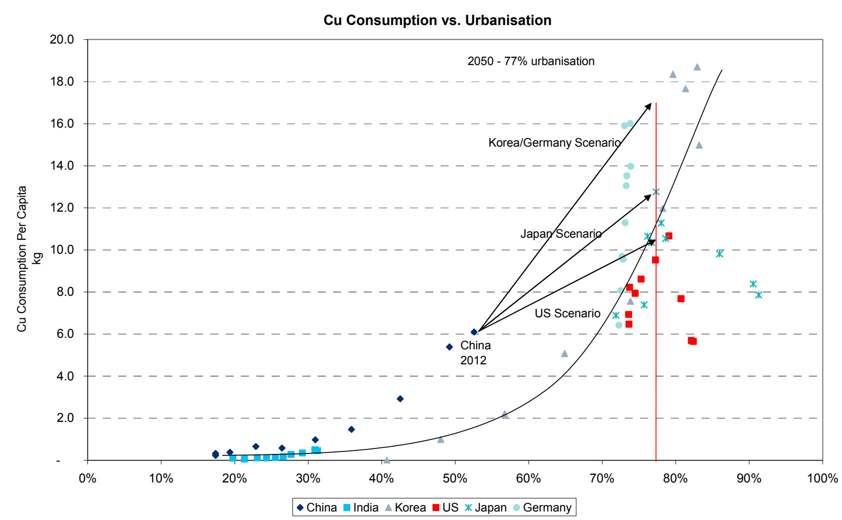
- Given the later cycle nature of copper demand it is unlikely that the copper demand/urbanisation ratio has peaked. Relative to peaks in the ratio of other countries China appears to still have some distance to travel being 14% below the US peak, 30% below Japan and 50% below Korea.
- On this basis we have used three scenarios to determine future demand based on peak ratios similar to **1)** the US **2)** Japan **3)** Korea/Germany
- In each scenario we have assumed that the peak occurs at an urbanisation rate of 77%, in 2050 according to the UN (Figure 17) which forecasts a population of 1.3bn. This is appears to be the average of where other nations historically peak.
- As with steel China is consuming ahead of its urbanisation support base. However with consumption still below peak there remains support for growth. As a result **we see growth in per capita consumption under all three scenarios.**

Figure 22. Our steel demand scenarios suggest significant potential diversion in demand trends



Source: World Steel, CRU, United Nations, Citi Research

Figure 23. While copper consumption is expected to increase under all three scenarios



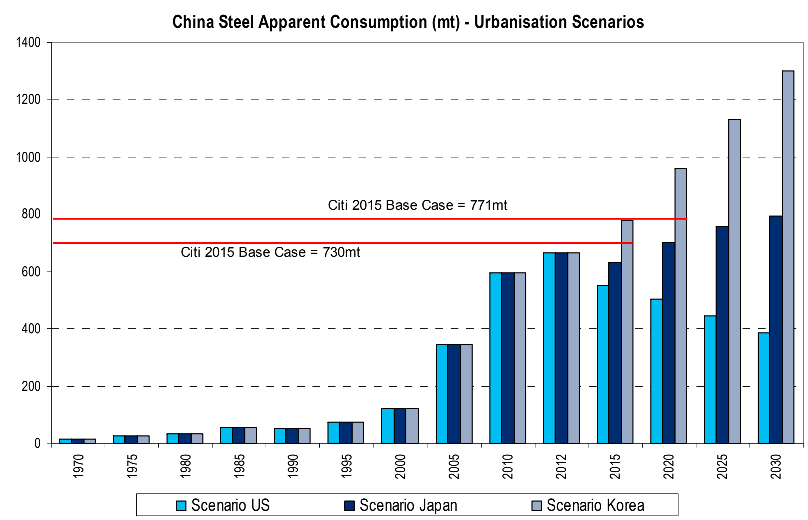
Source: Wood Mackenzie, United Nations, Citi Research

Demand likely to fall short for both copper and steel

- Our analysis suggests that demand is likely to fall short of expectations for **both copper and steel**
- As shown in Figure 24 urbanisation growth rates imply Chinese steel demand of 502-957mt in 2020 vs. Citi estimates for 771mt and consensus of >1bt
- For copper (Figure 25) consumption could be 9,724kt-11,737kt in 2020 compared to Citi on 12,126kt and consensus of c12,700kt
- However while we expect a shortfall in copper demand under all three scenarios the range is significantly tighter than in steel. For both commodities we regard the more bullish, Korean, outcome as the least likely. **For this to occur the growth rate in the consumption of copper and steel would have to be maintained at the same level of the super cycle.** With China transitioning away from investment this is a big ask in our view.
- Further, part of the reason for the decline in the consumption rates in the US and Japan is explained by the migration of primary manufacturing to China. For China to take another leg up in its urbanisation intensity would suggest further displacement of the manufacturing bases of these countries. It also suggests no impact from ‘re-shoring’ as US energy independence kicks in. It is likely in fact that the US begins to take share back from China.

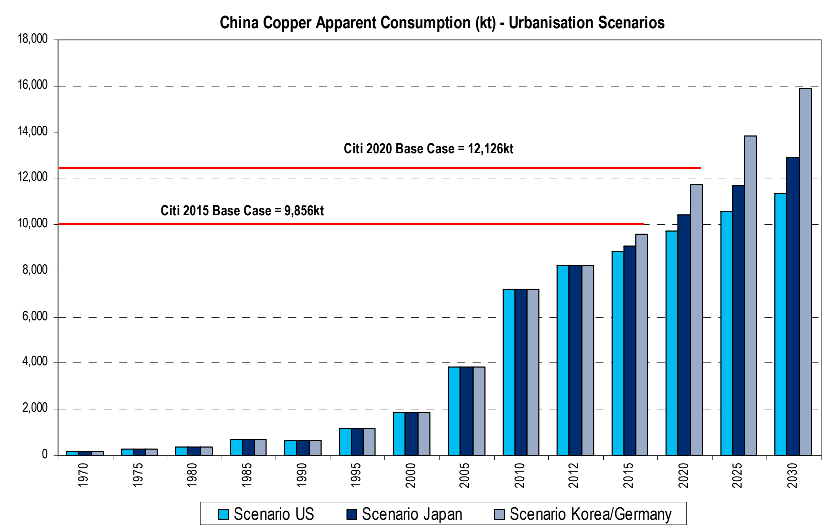
Source: Citi Research

Figure 24. Urbanisation implies steel demand of 502-957mt in 2020



Source: World Steel, CRU, United Nations, Citi Research

Figure 25. ...in copper our analysis suggests consumption of 9,724-11,737kt in 2020

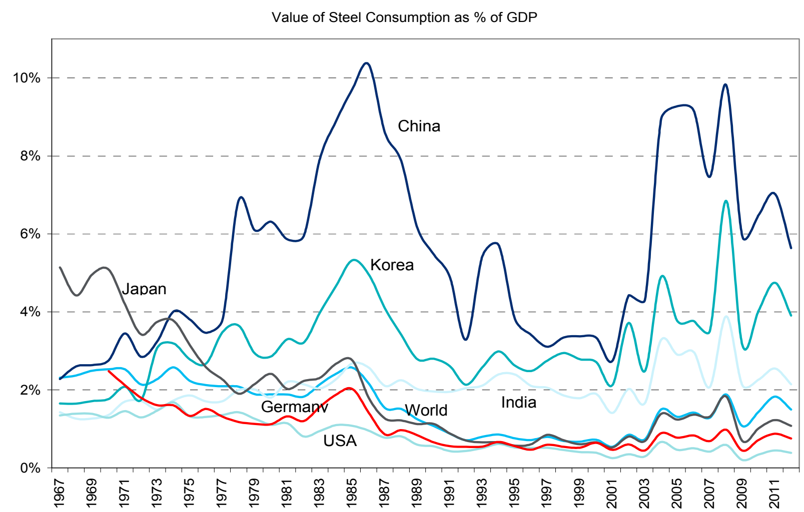


Source: Wood Mackenzie, United Nations, Citi Research

Method 2: Sustainable demand based on GDP

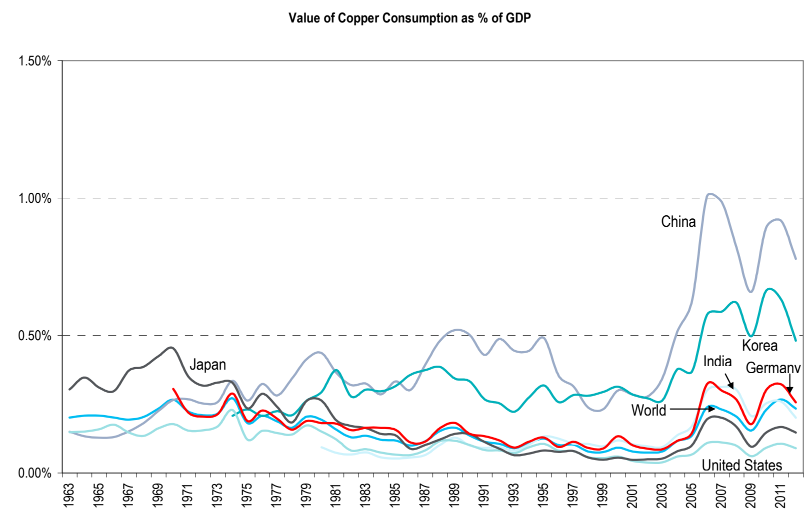
- Per capita consumption analysis assumes that end users will consume material regardless of the price. In our view this is an incorrect approach as it violates one of the basis tenets of economic demand and supply theory.
- We have therefore focused on value-in-use looking at the total value of steel and copper consumption relative to nominal GDP.
- **Since 2004 China has spent on average 8% of its GDP on steel.** This is in excess of both Japan and Korea during their rapid growth phases. As the below chart shows Korea's demand peaked at 7% of GDP in the 1980s. While we do not have the steel data to capture Japan's post war 'miracle years' its investment/GDP only reached 36.4% in 1973 vs. China's peak of 50% suggesting a lower steel intensity.
- Copper expenditure both in China and globally represents a smaller proportion of GDP. **China's consumption has however reached similar relative heights with average demand also 4x the global average.**
- The shift to a more mature, developed market model of consumer driven growth suggests that consumption will revert over time to the long term sustainable demand levels relative to GDP evident in more developed economies. **China's current spend relative to this maintenance baseline suggests this transition could be painful.**

Figure 26. Since 2004 China has spent on average 8% of its GDP on steel, 4x the global average



Source: Citi Research, World Bank, IMF, CRU

Figure 27. For copper China has spent 0.85% since 2005, still 4x the global average

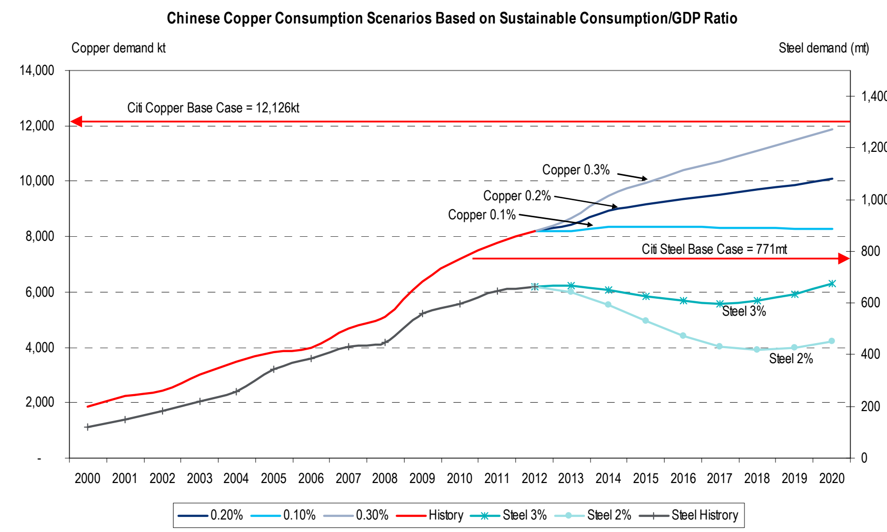


Source: Citi Research, World Bank, IMF, Wood Mackenzie

Demand again disappointing

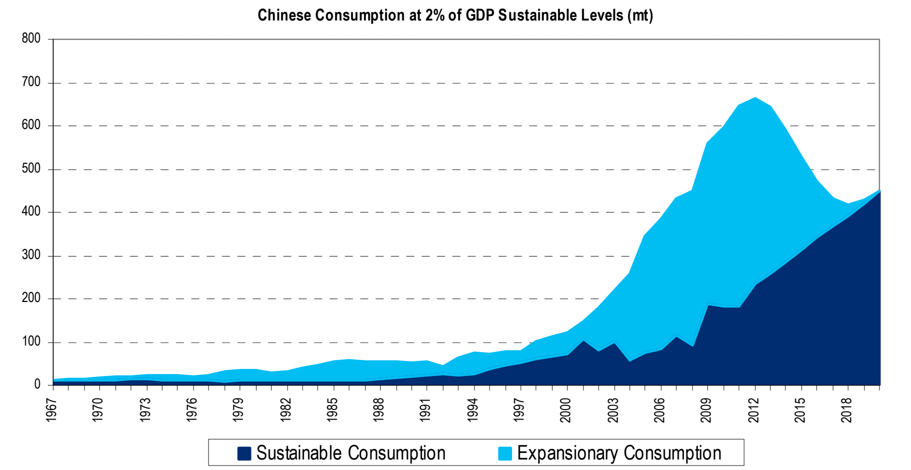
- We have tried to calculate China's sustainable level of consumption based on an underlying demand trend of:
- **1)** 0.1% of GDP in-line with the US **2)** 0.2% of GDP in-line with global averages **3)** 0.3% of GDP in-line with the historical average of Korea for copper
- **1)** 2% of GDP in-line with Japan's historical average **2)** 3% of GDP in-line with the lows following the 80s spike for steel
- For the purposes of this analysis we assume that anything above this maintenance level is expansionary spend and will therefore decrease to zero over time. We assume this time period is longer for copper than steel given its longer cycle demand profile.
- **Our analysis suggests steel demand in 2020 could range from 450-675mt while implied copper consumption is 8,278-11,884kt (Figure 28).**

Figure 28. Both copper and steel demand are likely to come in below our forecasts based on % of GDP analysis: steel demand could be 450-675mt with copper 8,278-11,884kt



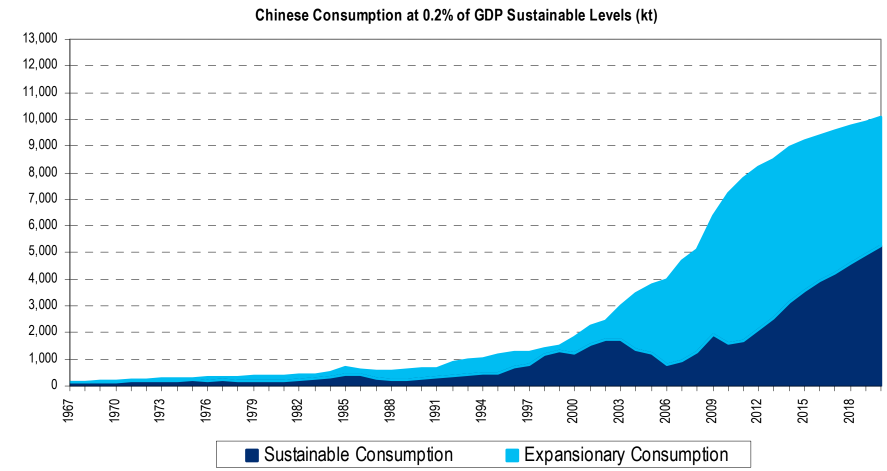
Source: Citi Research, World Bank, IMF, CRU, Wood Mackenzie

Figure 29. Based on a 2% of GDP assumption only 260mt of Chinese 2013 demand is sustainable



Source: Citi Research, World Bank, IMF, CRU

Figure 30. For copper the maintenance level in 2013 appears to be 2,522kt

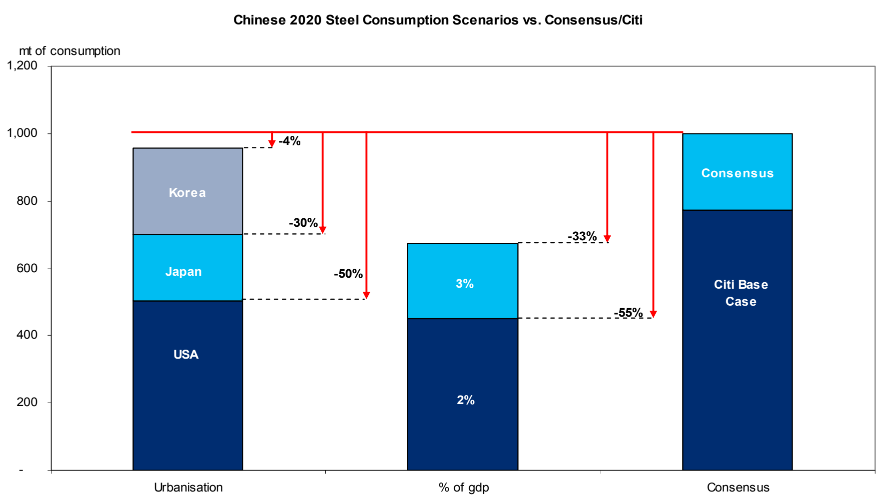


Source: Citi Research, World Bank, IMF, Wood Mackenzie

Most probable scenario: copper miss of c20%, steel by 30-55%

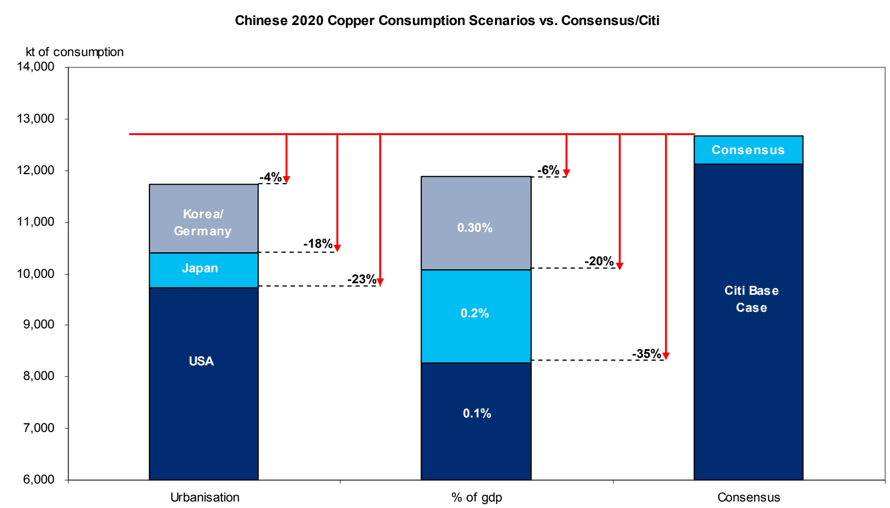
- Our top down work on steel and copper demand suggests we will see significant shortfalls against consensus numbers while Citi estimates could also be missed.
- For steel our numbers imply 450-957mt of demand from China by 2020. This represents a miss of 4-55% vs. consensus expectations of >1bt and a range of 42% below to 24% above Citi.
- In copper our analysis point to 8,278-11,884kt of demand, a range of 6-35% below consensus estimates of c12,700kt in 2020
- In our view the least likely outcome in for both commodities is where China emulates the consumption rates of Korea. As previously explained we see Korea as a special case and the size of China's economy would imply a seismic shift in global trade for this to occur.
- **As a result the most likely demand scenarios appear to be 450-700mt of steel and 10,081-10,404kt for copper representing shortfalls of 30-55% and 18-20% respectively**

Figure 31. Our analysis suggests steel demand could miss consensus by 4-55% with the most likely scenario c30-50% below



Source: Citi Research

Figure 32. Copper will also see a shortfall although not nearly as steep with demand potentially 6-35% below consensus and the most likely outcome 18-20%



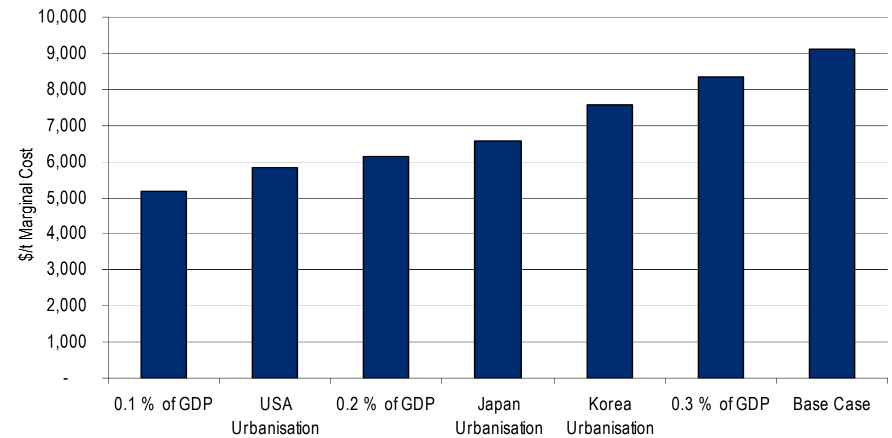
Source: Citi Research

Impact on the Copper Market

- Using our supply demand model and cost curve, we calculate the marginal cost for the industry under a range of Chinese demand scenarios (Figure 33). Under Citi's existing base case the marginal cost of copper would be just above $9,000/t (2020 nominal), while under the most bearish scenario – China spending 0.1% of GDP on copper – the marginal cost reduces to ~$5,000/t. **Only more bullish scenarios such as a Korean-like urbanization trend or 0.3% of GDP spent on copper, would see marginal cost remain above $7,000/t**

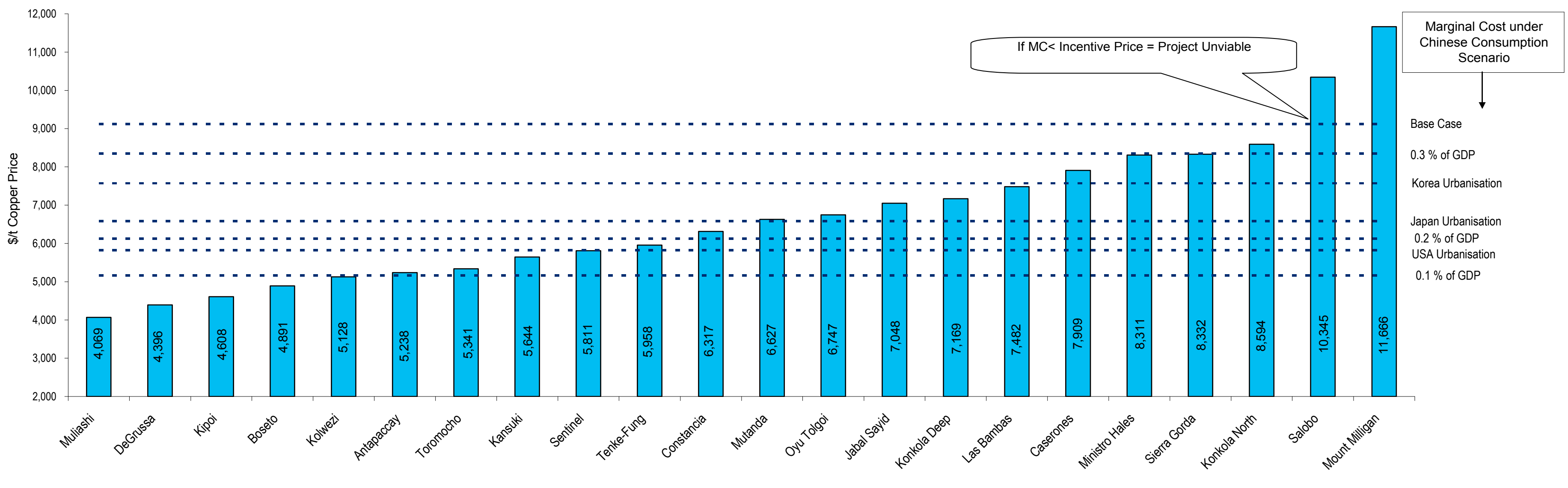
- The implications on the copper project pipeline would be significant; in Figure 34 we compare the incentive prices of key copper projects to the marginal cost of copper under each Chinese demand scenario. Under the 0.1% of GDP scenario, almost 75% of current projects would be uneconomical, as the marginal cost of copper would be lower than the incentive price for the project.

Figure 33. Copper Market Marginal Costs under varying Chinese demand



Source: Citi Research, Wood Mackenzie

Figure 34. Copper project incentive prices vs marginal costs under Chinese demand scenarios

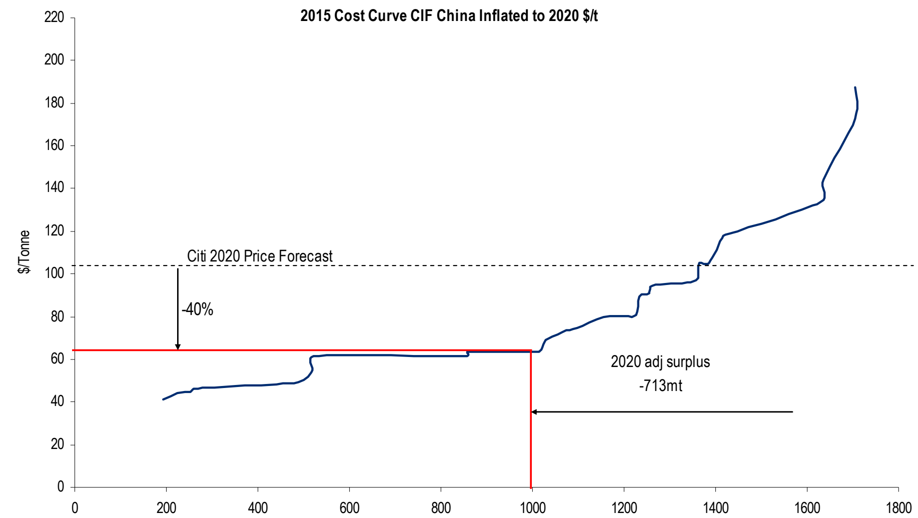


Source: Citi Research, Wood Mackenzie

Impact iron ore market

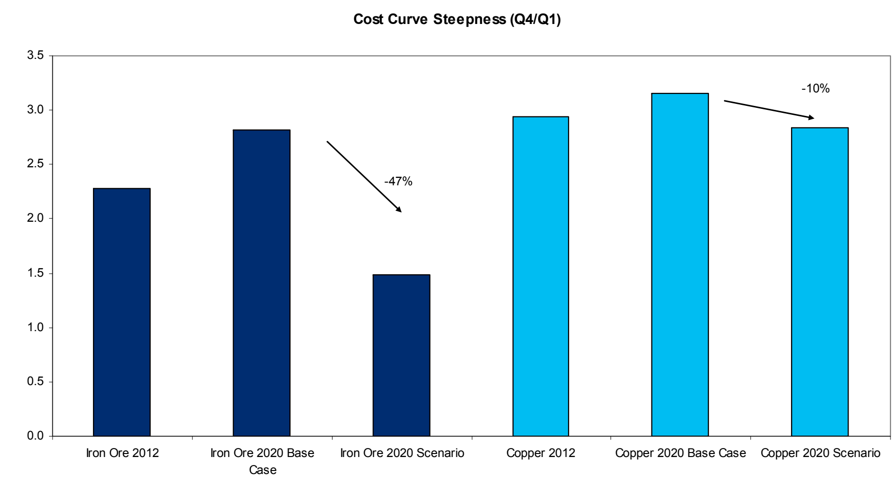
- A correction in Chinese steel demand to c500mt in 2020, in-line with our top-down 2% of GDP and USA urbanisation scenarios, would represent a shortfall vs. Citi's iron ore demand base case of 470mt vs. Citi's base case
- Combined with an existing expected surplus of 177mt this creates a net excess capacity of c700mt.
- Based on our 2015 global CIF cost curve, inflated out to 2020, **suggests price support at $64/t – this compares to our long run assumption of $105/t nominal or $80/t real**
- The resulting loss of capacity in both the copper and iron ore markets would result in a **dramatic flattening of the cost curve: by 47% for iron ore and 10% for copper**
- As shown in Figure 37 the relative steepness of the cost curve is a key driver of returns suggesting iron ore producers in particular face a drop in ROCE

Figure 35. 500mt of Chinese demand turn suggests price support at $64/t in 2020



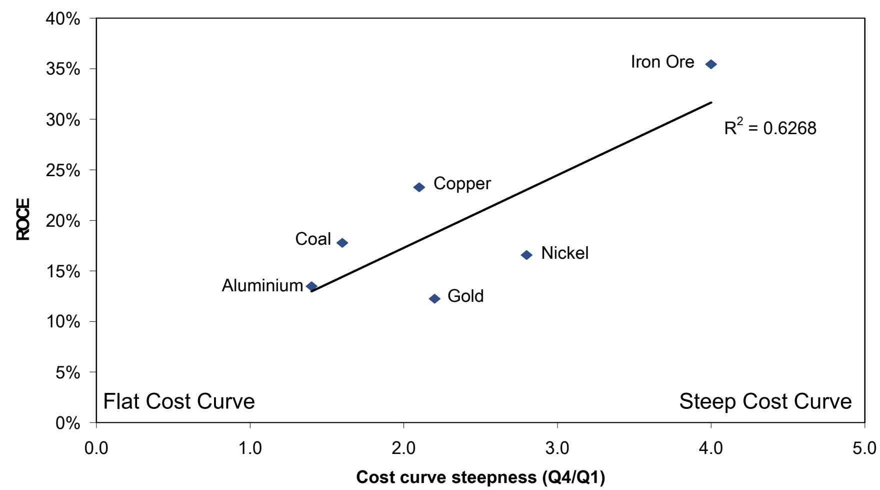
Source: Citi Research

Figure 36. The 2020 cost curve could compress by 47% in iron ore but just 10% in copper



Source: Citi Research

Figure 37. Implying copper producers have a more defensive returns profile



Source: Citi Research

Appendix A-1

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