

Edge of tomorrow: A tour of 2016-2020 mineral commodity markets

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Abstract

Analysis of past and future commodity markets and prices is akin to having access to a form of time machine that works accurately when travelling backwards but which remains imperfect when set to analyse the future.

Developments in mineral commodity markets in the 21st century have centred on the rapid demand-side emergence of China. Looking forward however, commodity markets will now be influenced by slower Chinese economic growth. Despite this, prices (in general) are still forecast to rise but will not revisit ‘China boom’ levels in the next five years. The possible exception is zinc which will experience tight supply as mature mines reduce output and in some cases are depleted. Some further commodities forecast to increase in price include alumina, aluminium, bauxite, coking coal, copper, nickel, platinum/palladium, potash, thermal coal, tin and uranium.

Consumers of commodity price forecasts should not use forecasts passively, instead taking an active role in understanding how forecasts are generated, their vulnerabilities, and importantly what best practice in improved forecasting may look like in future. Rather than just providing commodity prices forecasts therefore, this paper concludes with a discussion on how to improve forecasting itself. More accurate price forecasting requires successful step-change improvements to both analysis and process.

Keywords: Economic forecasting, mineral commodities, mineral economics, mineral markets, economics, commodity prices, China.

Introduction

Time travel is the abstract concept of movement by humans between different points in time in a manner analogous to moving between different points in space, typically using a hypothetical device known as a *time machine* (e.g. Wells, 1898). Unlike popular culture, scientific theory highlights a key paradox in time travel; in that it may be possible to visit the future, but not the past (Hawking, 2010). Forecasting, including of commodity prices, faces a similar problem: We can know the past, but we cannot visit and alter it; whereas we cannot

know the future, but we will all eventually arrive in it and we all also have some ability to affect the future. In summary, we know what past commodity prices were, and have a pretty good idea what caused their fluctuations, however they can no longer be changed. By contrast our understanding of future commodity prices and their dynamics is very limited, but collectively we have some ability, at very least to prepare for future price fluctuations; and to a limited extent, collectively influence commodity prices through both our actions as consumers (demand) and mining industry participants (supply).

In this paper, we use the analogy of time travel to look at mineral commodity markets in the period 2016 through to 2020. Inaccurate proxies for moving forwards in time do exist however (Trench & Sykes 2014), principally via commodity price forecasting through one or both of fundamental commodity market analysis (supply and demand) and also through technical analysis of price time-series (both of which methods can yield precise, if usually inaccurate answers). An often-used tool on our *time machine* dashboard involves due reference to both forward and derivative market transactions for specific commodity markets where these exist.

To extend the *time machine* analogy further, the lessons learnt from the past analysis of markets are sometimes not fully heeded when the forecasting time machine is set for dates in the future. That is, our collective ability to envisage the future forces that will shape commodity markets and prices remains limited. Put simply, we can too often underutilize the valuable lessons of the past when we use our *time machine* to analyze future commodity market developments. The opposite error is also a challenge, whereby past events and prices anchor and therefore unduly influence the forward thinking required to predict the future. Clearly our forecasting process remains very far from perfect when used to ‘travel’ forwards in time and thus reveal the nuances and prices of future commodity markets.

Travelling back in time: China as the principal driver of commodity markets

The period 2003 to 2008 witnessed strong price escalation across metal markets globally (Humphreys 2010). Recovery in commodity markets following a brief downturn due to the Global Financial Crisis that commenced in 2008 was swift, and was China-led. That is, strong demand from China on a scale exceeding expectations was the principal driver of commodity price escalation both prior to 2008 and thereafter. Specifically, the East Asian growth models (and in particular China) brought together some unique and specific features that fed into mineral demand. These included aligned political structures (from country through to provincial levels), a consensus towards reform and rapid growth, high savings rates and capacity for high investment intensity, decisive industrialisation policies and flexible labour, lack of delays in land access and strong state infrastructure investment. Additionally, an administratively controlled financial system that both channelled and favoured investment financing focused on compact/high density urbanisation (Perazzelli 2015).

For example, the combination of demand-side forces saw large growth in the contestable iron market driven by China’s urbanisation, industrialisation and associated infrastructure investment. The seaborne market increased from 530 Mtpa in 2000 to 1390 Mtpa in 2014. China accounted for almost all the growth (860 Mtpa) with iron ore imports increasing from 70 Mtpa in 2000 to 930 Mtpa in 2014. Over the period Chinese steel production increased from 125 Mtpa to 822 Mtpa (Perazzelli 2015).

Travelling forward in time: Commodity market drivers 'beyond China'

Whilst China will clearly remain a key influence upon commodity markets in the period to 2020 (and beyond), a repeat of the spectacular growth rates of consumption in China that have characterised the early years of this century are not expected. Chinese economic growth and related metals consumption growth are expected to moderate in the future from past expansion rates.

The relative impact of the moderation in China's demand outlook has different implications across the various major mineral and metals markets globally. Each market inevitably finds itself at a slightly different point in the cyclical ebbs and flows of supply and demand that characterise commodity markets. That is, the typical lag in supply-side production response to demand-side stimulus can create periods of market imbalance and consequently result in commodity prices both well-above and/or well-below what might be considered equilibrium level (Trench & Sykes 2014). The microeconomic twin forces of supply and demand are far from simple in detail of course. Demand is (in part) linked to the performance of the macroeconomy – but also to the technological advances for key end uses for individual metals and minerals. Such demand-side technological change can either enhance or destroy consumption. Supply is (in part) related to price and to price expectation – which trigger investment decisions – but critically is also influenced by the likes of supply-side technology advances and by a multitude of other non-technical issues that, for example, can prevent or advance the development of specific projects (Sykes and Trench, 2014; Trench et al. 2014).

Visions of the future: Individual commodity price forecasts

Base metals traded on the London Metal Exchange (LME) look set to be amongst the better performers across the spectrum of commodity markets in the period to 2020. The major LME markets of aluminium (including the upstream feedstock products in bauxite and alumina), copper, nickel and zinc are all forecast to experience periods of market deficit that will prompt price increases for each metal. Each of these metals has however experienced periods of market surplus for one or more years from 2011 to 2014, such that stocks of metals held by exchanges will first decline as an indicator of deficit in each market.

The following commodity outlook summaries are sourced from the relevant CRU Group commodity-specific forecasts. Those selected markets summarised here are highlighted in Fig. 1.

Aluminium: Forecast aluminium demand growth sits at around 3.5 per cent per annum led by the transport sector. Strongest growth in percentages terms will come from India and South-east Asia (Indonesia, Thailand and Vietnam). Following a period of sustained market surplus, market deficits are expected, and will prompt the need for investment in new smelting capacity by the end of the decade.

Aluminium feedstock – Alumina: Rising alumina demand follows sequentially in a demand-pull context from the favourable outlook for aluminium metal demand growth. For example China's ongoing alumina needs to feed smelters will provide support for prices as robust import demand continues despite the concurrent ramp-up in domestic Chinese alumina production. Alumina prices are expected to rise by around 15 to 20 per cent. Indian alumina

demand is set to rise at the fastest pace globally reflecting the strong growth in aluminium smelting there.

Aluminium feedstock – Bauxite: Bauxite prices into China are forecast to rise in the period 2015 to 2019 driven by ongoing export restrictions from Indonesia. Malaysia has stepped up as a significant 2015 bauxite exporter to China with around 12 million tonnes exports forecast this year. New mines from Malaysia, Australia and Guinea are expected to supplement expansions at existing mines in servicing global market growth requirements.

Coking Coal: Demand for coking coal has taken a hit due to the downturn in the Chinese steel sector. That said; prices have fallen so low into the industry cost curve that some level of price recovery becomes inevitable as supply responds. Steel demand ex-China is more positive driving overall consumption increases. From prices below US\$100 per tonne (FOB Australia) in 2015-16, expect nominal prices to move upwards towards into the US\$120-US\$140 per tonne range through 2017-19 in nominal terms.

Copper: Refined copper demand will reach around 27 million tonnes in the next decade. The market is forecast to tighten beyond 2016. Some mine owners are choosing to hold back on committing capital to expansions. Delays to new supply are forecast to drive rising copper prices and market deficit late this decade. Around 6 million tonnes of copper supply per annum is required in ten years' time from new projects not presently committed to mine development.

Nickel: Global primary nickel consumption is forecast at 1.93 million tonnes for 2015. The largest demand-side driver in nickel is the rate of growth in stainless steel, which is forecast to grow at 5.3 per cent per annum through to 2019. Supply developments in nickel remain focused on the transition in Indonesia from export supply of ores towards in-country nickel pig iron (NPI) production. Further reduction in Chinese NPI production is anticipated as a consequence.

Palladium/Platinum: Global gross consumption in 2014 of 10.8 million ounces of palladium forms a platform for further market growth in the period to 2019. Recent consumption growth in the United States and Chinese vehicle markets, coupled with ever-tightening emissions regulations, bode well for the demand side outlook. Global automobile sector palladium purchases reached 7.3 million ounces in 2014. Supply growth will continue, most notably from South Africa and Russia, although intermittent disruptions to mine supply will likely persist. Overall, market potential exists for palladium prices to rise significantly, with US\$1000 per ounce within reach in nominal terms to 2019. The global platinum market is forecast to remain in deficit for the period to 2018 and similarly benefit from positive market fundamentals, albeit that full supply has now resumed from high-cost mines in South Africa.

Potash: Prices are forecast to continue recovery beyond 2015 from the significant price falls of 2014. Maintaining affordability by farmers is the challenge to a significant potash price rise however, notably for non-US consumers who face a stronger United States dollar (raising the cost of US\$-denominated potash imports). Lower crop prices are a further threat in this regard – with the principal exception to this rule is China where support prices for crops are in place. Intermittent mine supply challenges are also forecast to continue in Russia and Canada, allowing project developers elsewhere opportunity.

Thermal Coal: Depressed thermal coal prices have eaten deep into the industry's cost curve in 2014 and 2015 reflecting spot prices into China of around US\$70 per tonne (2014, for 5,500 kcal/kg coal) and US\$65 per tonne in 2015. Relief is on the horizon however with prices anticipated to gradually rise into 2016 and beyond, and return to around US\$80 per tonne by 2019. Ex-China demand growth is forecast as the principal market driver set to grow at 3 per cent per annum.

Tin: Prices are likely to remain within a \$14,000 to \$16,000 per tonne range in the near-term. Demand for tin is solid if not spectacular with continued substitution by tin of lead solder in electrical applications. Increased production from Myanmar into China has to date stunted a tin price revival. A reduction in Chinese tin concentrate imports (from Myanmar) and Indonesian tin exports are however considered likely over time, opening the possibilities for new mine supply as tin prices rise.

Uranium: China is emerging as the principal driver of demand-side growth for the energy metal. On the supply-side the Kazakhstan is forecast to remain the leading producer through In-Situ Leach (ISL) technology. Uranium prices since the Fukushima tragedy of 2011 have remained below levels required to induce new mine supply. Increases in uranium price to prompt new supply in order to fulfil Chinese demand are anticipated.

Zinc: US dollar prices in the order of US\$2,000 per tonne remain insufficient to prompt final investment decisions to bring new mine developments to market, even though investment in such projects is still needed to offset mine closures in the 2016 through to 2019 periods. A rise in the price of zinc remains the only way to pull the market back to equilibrium. Exchange-held zinc stocks are expected to undergo dramatic draw-down ahead of a 2016-17 price rise which could exceed US\$3,000 per tonne.

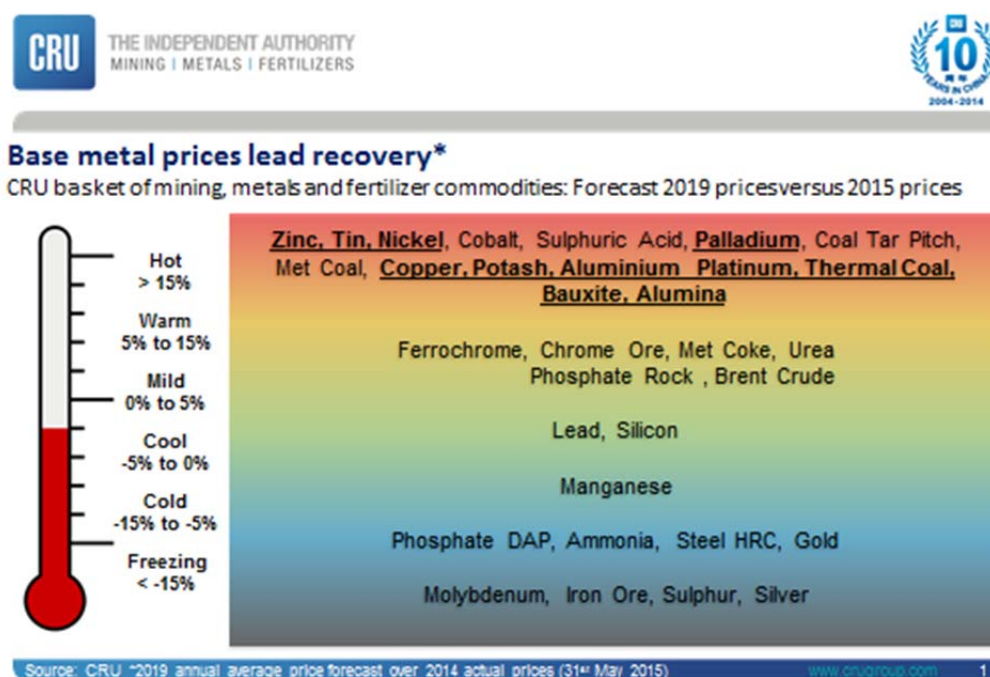


Figure 1. The CRU Commodity Heat Chart for June 2015. The chart highlights the commodities covered by CRU analysts that are forecast to either increase or decrease in price by 2019, from 2015 prices. NB: a forecast of increased prices by 2019 does not indicate that prices will continually rise to that point, some commodities are forecast to fall then rise, and vice versa. Source: CRU.

Malfunctions with the ‘time machine’: Recent failures of forecasting

To continue the analogy of the *time machine*, frequently in the various fields of forecasting the dates of the future are input into the machine, but after much whirring and work, the *time machine* stays where it is and does not arrive in the future. The *time machine* and the inaccurate forecasts are left in the past.

Failure of the forecasters

The latter half of the 20th century was pervaded by a sense of certainty (Silver, 2012). Significant advances across multiple academic fields and scientific and technological endeavours, within the context of the Western victory of liberal democracy and free-market capitalism over the Soviet Union, communism and centralisation, created a sense of certainty and completion. The zeitgeist of the time was perhaps best typified by Francis Fukuyama’s popular book: “The End of History and the Last Man” (1992), in which he argued that mankind had completed its ideological evolution. Ominously however, Nobel Memorial Prize winning economist, Paul Krugman described the era (specifically the 1970s) as the high point for “vast amounts of theory, applied to extremely small amounts of data” (Silver, 2012).

The beginning of the 21st century was however marked by two major events that destroyed this confidence and certainty. Both the terrorist tragedy of September 11, 2001 and the Global Financial Crisis in 2008-9 were unpredicted events (conspiracy theories and revisionism aside) of enormous magnitude. The failure of prediction in these instances brought two new, now infamous phrases to the lexicon, which better reflect the mood of the present. First, Donald Rumsfeld (2002), United States Secretary of Defence at the time of the 9/11 tragedy, popularised the difference between “known unknowns” and “unknown unknowns”. Second, Nassim Taleb (2008) popularised the concept of “Black Swans”: low probability, high impact events, which are only recognisable in hindsight; and the danger they presented to the global financial system, which at the time was tipping into crisis.

Failure of the economic forecasters

Following the Global Financial Crisis, particular criticism has been reserved for economic and financial forecasters, with many recent, popular books written on the subject, of which examples include, but are not limited to: Taleb (2008); Hubbard (2009); Morris (2009); Reinhart and Rogoff (2009); Soros (2009); Tett (2009); Gardner (2010); McDonald (2010); Ross Sorkin (2010); Lewis (2011a, 2011b); Das (2012); Roubini (2011); Silver (2012); Eichengreen (2014) and so on! The general thesis of these texts is that conventional economic and financial forecasts frequently fail to see either the ups or downs of various economies and markets (though opinions as to why vary greatly within the referenced texts). Even the most eminent of economists recognise that this is at least a source of some dark humour, with Samuelson & Nordhaus (2010, xxiv) directing students towards a good website for such jokes, at the beginning of their textbook “Economics”, which has for nearly 70 years has served as the authoritative text on the subject.

Failure of the ‘mineral’ economic forecasters

Mineral economics has not been immune to the forecasting inaccuracies of its parent field, with mineral economists (and market analysts) struggling to forecast both the start (and potentially end) of the commodities supercycle and the impact of the Global Financial Crisis.

Humphreys (2010) highlights that not only were the commodity price bears caught out by the rapid rise of commodity prices in 2005-6, but even the bulls failed to anticipate the scale and broad nature of the price increases. Similarly, it was notable that mining companies themselves were largely not prepared for the demand increase having continually underinvested in new capacity up to this point (Humphreys, 2010).

Moving forward to the Global Financial Crisis, and focusing in on the Reuters Poll of copper market analysts, whilst the 2008 forecast was not too far off the overall 2008 average price (US\$6779/tonne versus US\$6969/tonne) and correctly predicted 2009 prices would be lower than 2008 prices; users of the forecasts would be forgiven for thinking these forecasts did not portend what actually happened, as demonstrated in Fig. 2. Again the 2009 forecasts correctly predicted 2010 prices would be higher than 2009 prices, but missed the scale of the price recovery and that by the end of 2010 prices would be heading towards record nominal highs. Similarly, copper futures (arguably a consensus forecast amongst active market participants) did not see the substantial fall and rise of 2008 and 2009 from just a few months out (Reichsfeld and Roache, 2011), as demonstrated in Fig. 3.

More recently there has been much debate over the end of the commodity supercycle. Although a number of voices (e.g. Berthelsen, 2013; Bishop, 2013; Clinch, 2013; Farchy and Blas, 2013; Hume, 2014) could be said to have called the end of the ‘commodities supercycle’ (which at least some of this paper’s authors do not agree has ended); the specifics of which commodity prices would fall (or collapse), when and by how much seem to have caught at least some analysts and companies out. The recent falls in the gold (Cassidy, 2013; Critchlow, 2013; Vardi, 2013); oil (Krauss, 2015; McCain, 2015) and iron ore sectors (Ingram, 2015; Stringer, 2015); perhaps the three most important commodity markets, were all accompanied by surprise, and even an element of conspiracy theory over the timing, magnitude and velocity (Cassidy, 2013; Gardner, 2015; Krauss, 2015). Such surprise has not been restricted to the major commodities, with the recent fall in tin prices, surprising analysts with its magnitude and cause (Bromby, 2014; Gardiner and Sykes, 2015). All that is clear from this is that the future is at least uncertain, if not unknown and current methods of forecasting not accurate.

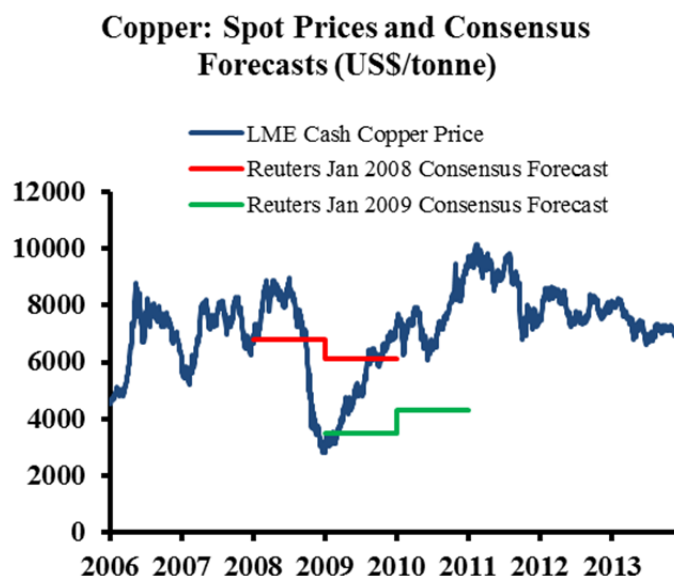


Figure 2. The Reuters Poll of financial analyst copper price forecasts for the key years of 2008 to 2010, compared to the actual copper price through that period. Data: Reuters, Metal Pages.

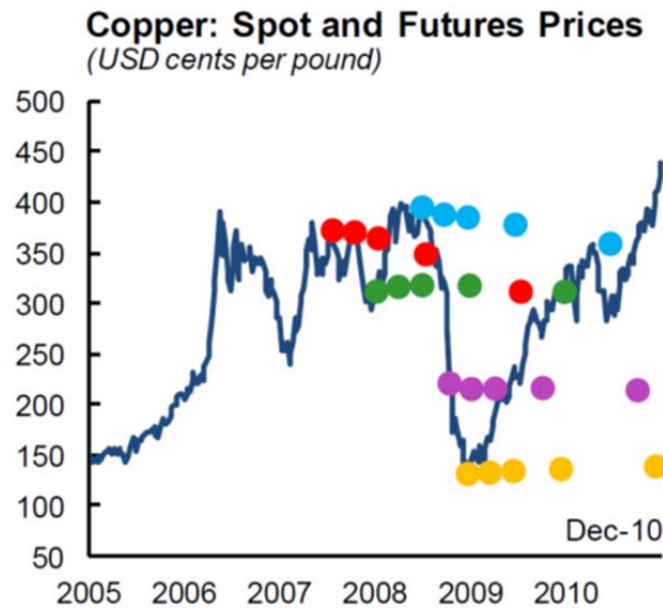


Figure 3. Copper futures prices in the key period of 2007-2009 compared to actual copper price movements.
Source: Reichsfeld and Roache (2011) using data from Bloomberg.

Why we should still try to build a ‘time machine’: Why commodity price forecasting is still important

All the authors of this paper are practicing “forecasters” in the mining and commodities industry. Thus, all, to some minor extent are guilty of perpetrating this situation. That been said all (and with the assumption that this applies to many within the business of forecasting) are acutely aware of the limitations our current techniques for envisaging the future. However, the paradox, as emphasised by Charles, F. Kettering’s quote “my interest is in the future because I’m going to spend the rest of my life there” is that the difficulty of forecasting the future is only matched by its importance. It is for this reason those in academia, industry, finance and many less reputable vocations produce forecasts of the future, with greater, or usually lesser, levels of both accuracy and precision (Silver, 2012).

In the context of the mining industry, this importance is emphasised by the sheer breadth of parties interested in the future of the industry: Mining companies assessing future drivers of competitiveness; governments calculating future tax and royalty revenues; financiers identifying undervalued companies; suppliers anticipating their client’s needs; explorers seeking the next frontier; consultants advising strategies for companies to adopt; academics hoping to understand where the industry as a whole is heading and so on.

With the recent track record of forecasts in mind, sceptics may suggest that the future is unknown and thus forecasting, of any sort, is intellectually bankrupt. To this though, by definition, all forecasters disagree that the future is ‘completely unknown’, some elements are predictable or at least pre-determined (Wack, 1985a, 1985b). Indeed, as the great economic historian, John Kenneth Galbraith (1991) points out; economics only thrives when there is significant economic turbulence present to challenge the mind. Thus in parallel with the muddled economic (and other) forecasts of the early 21st century, is the wider acceptance and study of the role of uncertainty in forecasting and indeed in many fields of academic and commercial endeavour (Silver, 2012). We can know something about the future, it is just uncertain.

Re-building the ‘time machine’: Towards better quality commodity market forecasts

To extend the metaphor laid out by Donald Rumsfeld (2002), increasingly forecasters are now working on the three areas of uncertainty that affect forecasts. The first two were described by Rumsfeld himself: “known unknowns” and “unknown unknowns”. In addition, these pairs can be restructured into a less discussed, but perhaps more dangerous, third phrasing (Silver, 2012): “unknown knowns”, in this case describing things that analysts think they know, but actually do not.

Known unknowns

First, there has been an acceptance that ‘what you do not know can hurt you’ thus to deal with the uncertainty surrounding “known unknowns” there has been resurgence in the use of Bayesian statistical methods (Bayes and Price, 1765) in forecasting (Silver, 2012). This probabilistic approach to forecasting emphasises accuracy over precision, in contrast to more commonly applied frequentist techniques, which arguably prioritise precision over accuracy (Silver, 2012). The aim of such forecasting is to be approximately correct, rather than precisely wrong. The use of Bayesian maths and related fields such as options theory are increasingly used in mineral economics (Guj, 2013).

Unknown unknowns

Secondly, there is the realisation that just because something is difficult to understand and indeed quantify or study objectively, does not mean it is not important – this is the area of “unknown unknowns”. Popular authors, such as Douglas W. Hubbard (2010), who operates in the commercial sphere, emphasise the importance of using a variety of techniques to learn at least something about the “unknown” even if it is rather vague, i.e. trying to move objects from the “unknown unknown” to the “known unknown”. Similarly, in the academic realm “mixed methods” approaches to research, which combine subjective (qualitative) and objective (quantitative) techniques are becoming more popular in academia (Bryman and Bell, 2011). Again in the field of forecasting, which necessarily crosses the boundary between objective and subjective (Silver, 2012) this sometimes involves Bayesian statistics (Bayes and Price, 1765). However, more subjective techniques, such as scenario planning (Rigby and Bilodeau, 2007; Ramirez, 2008; Wilkinson and Kupers, 2013; Ramirez and Selin, 2014) are also gaining greater acceptance.

Unknown knowns

Finally, there is increasing understanding that we do not always know what we think we know – so called unknown knowns. Perhaps the most important area of work on this issue is in biases and heuristics: where our unconscious misleads us in our understanding of an issue. Daniel Kahneman has received a Nobel Memorial Prize in Economics for his work in this field, with most of his work summarised in the book: “Thinking, Fast and Slow” (2011). Discussion of heuristics such as anchoring, availability and familiarity, which lead to bias in analysis, are increasingly common in both business and academia. The work has particularly important implications for expertise, where it appears there are a number of invalid areas of expertise, where the operating environment is just too uncertain and the opportunity for learning (i.e. developing expertise) too limited, so called ‘low validity environments’ (Kahneman and Klein, 2009). Long term commodity price forecasting may fall into this field.

As well as ‘unconscious’ unknown knowns caused by heuristics, there are also more conscious forms of “unknown knowns”, where analysts refuse to recognise the truth either because the implications are unpleasant, or because they are paradigm locked and unable to break their thinking. In these cases external interventions, often led by consultants (Everett, 2013) and techniques such as scenario planning are invaluable in breaking taboos and reframing ideas (Ramirez, 2008).

The Good Judgement Project

One of the most active groups trying to improve the field of forecasting is the Good Judgment Project (Harford, 2014). The programme is nominally focussed at geopolitical forecasting (with funding coming from the US Intelligence Advanced Research Projects Activity); however it seems likely the lessons learned are useful for all fields of forecasting. The project is led by psychologist *cum* political scientist, Philip Tetlock, author of “Expert Political Judgment” (2009). Over several decades, including most recently with the Good Judgment Project, Tetlock has collected and analysed tens of thousands of forecasts, measured their accuracy and even developed a terminology for describing forecasters: foxes – broad, intuitive, self-critical; or hedgehogs – deep, logical, assured (Harford, 2014). He has also identified ‘superforecasters’ who over time do consistently outperform other forecasters, making more accurate forecasts (Harford, 2014).

Tetlock has distilled down ten key aspects which ‘superforecasters’ utilise, presenting them with the acronym “CHAMPS KNOW” (Good Judgment Project, 2014a). Slightly abridged versions, to make them more specific to commodity price forecasting are detailed below:

Comparisons should inform your probability estimates;

Hunt for the right information;

Aadjust and update your forecasts regularly;

Mathematical and statistical models help;

Post-mortem analyses help you improve;

Select the right questions to answer and forecasts to make;

Know the key players i.e. major miners and mineral consumers who have the ability to influence the market;

Norms and protocols matter (think about those of the forecasting institution also);

Other perspectives should also inform your forecasts;

Wildcards, accidents and black swans can catch you out if you do not consider the risk of irreducible uncertainty;

In addition to the rules above, the Good Judgment Project (2014b) has also identified that teams make better forecasts than individuals, even ‘superforecasters’. This latter observation therefore supports techniques such as scenario planning which frequently utilise group work

(Ramirez, 2008) and lending support to the ideas of ‘forecasting companies’ such as CRU Group.

Making better commodity price forecasts

In summary, whilst the commodity price forecasts presented at the beginning of this paper stem from the best practice at present; the authors acknowledge that much can be done to improve commodity price forecasting. As such, the authors highlight a number of future developments that should see the quality of commodity price forecasting improved further, including:

- (1) Improvements in the **availability and quality of historical data**. A better understanding of history helps us to understand previous commodity drivers as well as the relationship between different data points. For example, as more and better Chinese data are made available this should allow better forecasts to be made.
- (2) **Better utilisation of forecasts** with a focus on drivers and key assumptions rather than commodity price levels themselves. This allows users to both own the ‘world’ in which the forecast is built and recognise when that ‘world’ is no longer possible.
- (3) Improvements in **recognising the weakness of human bias**, our cognitive models. As our understanding of key issues, such as the power of the anchoring effect upon human thinking develop further, we will of necessity be driven to find alternative and better methods of forecasting price.
- (4) **Wider adoption of scenario planning**. Scenario planning allows adopters to create of range of different credible versions of the future ‘different worlds’. This allows users to plan for different scenarios and identify leading indicators that suggest which path the world is taking.
- (5) To take advantage of additional data and to correctly identify drivers and key assumptions stronger forecasting models are required. **Improvements in econometric modelling techniques** allow us to move away from simple stock-consumption / price ratio equations to more sophisticated algorithms. These models, if well designed, reduce human bias whilst still including judgement and allow easier scenario development

Conclusions

From 2016 onwards commodity markets will be influenced by slower Chinese economic growth. Despite this, prices (in general) are still forecast to rise beyond 2015 but will not revisit ‘China boom’ levels. The possible exception is zinc which will experience tight supply as mature mines reduce output and in some cases are depleted. Amongst others, some further commodities with potential to increase in price include alumina, aluminium, bauxite, coking coal, copper, nickel, platinum/palladium, potash, thermal coal, tin and uranium.

Commodity price outlooks for base metals indicate a period of stronger prices relative to bulk commodities. Gold prices (although not a specific focus of this paper) are amongst the most difficult to forecast – gold being part commodity and ‘currency’. Positive and negative gold price scenarios are possible; the former (dominant) negative price scenario anticipates

resurgence of the US economy - however an alternative positive price scenario envisages potential 'Black Swan' impact of China-led breakout in gold demand for example.

Some things will not change with time: Mineral commodity prices are prone to increase, sometimes spectacularly, when material is scarce and when demand is robust and then prone to fall once again when material is readily available and demand is satisfied. Such supply-demand cycles are here to stay.

Despite the progressive evolution in trading platforms and derivative products that are available to commodity market participants, the accurate prediction of prices is far from perfect. A number of future developments should see the quality of commodity price forecasting improved further.

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References

- Bayes, T. and Price, R. 1765. An Essay towards solving a Problem in the Doctrine of Chances. Philosophical Transactions of the Royal Society of London 370-418.
- Berthelsen, C. 2013. Investors, Analysts See End of Commodity 'Supercycle'. The Wall Street Journal, 22 July [online]: <http://www.wsj.com/articles/SB10001424127887324144304578619672666497416> [Accessed: 3 July 2015].
- Bishop, K. 2013. Warning: 'Prepare' for Commodity Supercycle End. CNBC, 3 June [online]: <http://www.cnbc.com/id/100779278> [Accessed: 3 July 2015].
- Bromby, R., 2014, Burmese exports dent hopes for tin sector, The Australian, 10 November, p29.
- Bryman, A. and Bell, E. 2011. *Business Research Methods*. Third edition. Oxford University Press, Oxford. 765 p.
- Cassidy, J. 2013. Why the Price of Gold Is Plummeting: Six Theories. The New Yorker, 15 April [online]: <http://www.newyorker.com/news/john-cassidy/why-the-price-of-gold-is-plummeting-six-theories> [Accessed: 3 July 2015].
- Clinch, M. 2013. Commodity Super Cycle Is Dead: Citi. CNBC, 15 April [online]: <http://www.cnbc.com/id/100641156> [Accessed: 3 July 2015].
- Critchlow, A. 2013. Gold price collapse is the worst for 30 years. The Telegraph, 28 December [online]: <http://www.telegraph.co.uk/finance/commodities/10540875/Gold-price-collapse-is-the-worst-for-30-years.html> [Accessed: 3 July 2015].
- Das, S. 2012. *Traders, Guns and Money: Knowns and Unknowns in the Dazzling World of Derivatives*. Financial Times/Prentice Hall, New York. 384 p.
- Eichengreen, B. 2014. *Hall of Mirrors: The Great Depression, The Great Recession, and the Uses-and Misuses-of History*. Oxford University Press, Oxford. 520 p.
- Everett, J.E. 2013. Paradigm lost. Applied Earth Science (Trans. Inst. Min. Metall. B), 122, 2:58-65.
- Farchy, J. and Blas, J. 2013. Commodities traders call end of 'supercycle'. Financial Times, 26 June [online]: <http://www.ft.com/intl/cms/s/0/d76d040a-de76-11e2-b990-00144feab7de.html#axzz3eofZq7M2> [Accessed: 3 July 2015].
- Fukuyama, F. 1992. *The End of History and the Last Man*. Penguin Books, London. 452 p.
- Galbraith, J.K. 1991. *A History of Economics: the past as the present*. Penguin, London. 324 p.
- Gardiner, N.J. & Sykes, J.P., 2015. Myanmar: The Black Swan of Global Tin? ITRI China International Tin Forum, Shanghai, China, 18-20 May.

- Gardner, D. 2010. *Future Babble: Why Expert Predictions Fail – and Why We Believe Them Anyway*. McClelland & Stewart, Toronto. 320 p.
- Gardner, J. 2015. Andrew Forrest reveals mysterious warning of the iron ore price collapse. Australian Financial Review, 22 May [online]: <http://www.afr.com/business/mining/iron-ore/andrew-forrest-reveals-mysterious-warning-of-the-iron-ore-price-collapse-20150522-gh7kfp> [Accessed: 3 July 2015].
- Good Judgment Project. 2014a. Training – CHAMPS KNOW, December, Unpublished presentation.
- Good Judgment Project. 2014b. Training – Teaming, December, Unpublished presentation.
- Guj, P. 2013. Chapter 10. Mineral Project Evaluation – Dealing with Uncertainty and Risk. Australian Institute of Mining & Metallurgy Monograph 29, Mineral Economics. Second Edition p.145-176.
- Harford, T. 2014. How to see into the future. Financial Times, 5 September [online]: <http://www.ft.com/intl/cms/s/2/3950604a-33bc-11e4-ba62-00144feabdc0.html> [Accessed: 3 July 2015].
- Hawking, S. 2014. How to build a time machine. Daily Mail, 28 April [online]: <http://www.dailymail.co.uk/home/moslive/article-1269288/STEPHEN-HAWKING-How-build-time-machine.html> [Accessed: 3 July 2015].
- Hubbard, D.W. 2009. *The Failure of Risk Management: Why It's Broken and How to Fix It*. John Wiley & Sons, Hoboken. 308 p.
- Hubbard, D.W. 2010. *How to Measure Anything: Finding the Value of “Intangibles” in Business*. John Wiley & Sons, Hoboken. 320 p.
- Hume, N. 2014. Investing at the end of a supercycle. Financial Times, 10 October [online]: <http://www.ft.com/intl/cms/s/0/06491f0c-5040-11e4-9822-00144feab7de.html#axzz3eofZq7M2> [Accessed: 3 July 2015].
- Humphreys, D. 2010. The great metals boom: A retrospective. Resources Policy 35: 1-13.
- Ingram, T. 2015. Iron ore price crash erases \$74b in market value. Australian Financial Review, 20 April [online]: <http://www.afr.com/business/mining/iron-ore/iron-ore-price-crash-erases-74b-in-market-value-20150420-1mo522> [Accessed: 3 July 2015].
- Kahneman, D. and Klein, G. 2009. Conditions for Intuitive Expertise: A Failure to Disagree. American Psychologist, 64, 6 (September): 515-526.
- Kahneman, D. 2011. *Thinking, Fast and Slow*. Penguin, London. 443 p.
- Krauss, C. 2015. Oil Prices: What's Behind the Drop? Simple Economics. New York Times, 30 April [online]: http://www.nytimes.com/interactive/2015/business/energy-environment/oil-prices.html?_r=0 [Accessed: 3 July 2015].
- Lewis, M. 2011a. *Boomerang: The Meltdown Tour*. Penguin, London. 252 p.
- Lewis, M. 2011b. *The Big Short: Inside the Doomsday Machine*. Penguin, London. 287 p.
- McCain, B. 2015. The Facts Behind Oil's Price Collapse. Forbes, 9 February [online]: <http://www.forbes.com/sites/brucemccain/2015/02/09/the-facts-behind-oils-price-collapse/> [Accessed: 3 July 2015].
- McDonald, L. 2010. *A Colossal Failure of Common Sense: The Incredible Inside Story of the Collapse of Lehman Brothers*. Ebury Digital, London. 368 p.
- Morris, C.R. 2009. *The Two Trillion Dollar Meltdown: Easy Money, High Rollers, and the Great Credit Crash*. PublicAffairs, New York. 240 p.
- Perazzelli, P. 2015. China iron and steel market synthesis. Unpublished report.
- Ramirez, R. 2008. Forty Years of Scenarios: Retrospect and Prospect. In: *Mapping the Management Journey: Practice, Theory, and Context*, Dopson, S. and Earl, M. eds. Oxford University Press, Oxford: 307-319.
- Ramirez, R. and Selin, C. 2014. Plausibility and probability in scenario planning, Foresight, 16, 1:54-74.
- Reichsfeld, D.A. and Roache, S.K. 2011. Do Commodity Futures Help Forecast Spot Prices?. IMF Working Paper 11/254: 1-25.
- Reinhart, C.M. and Rogoff, K. 2009. *This Time Is Different: Eight Centuries of Financial Folly*. Princeton University Press, Princeton. 512 p.
- Rigby, D. and Bilodeau, B. 2007. A Growing Focus on Preparedness, Harvard Business Review, July-August: 119-127.
- Ross Sorkin, A. 2010. *Too Big to Fail: Inside the Battle to Save Wall Street*. Penguin, London. 616 p.
- Roubini, N. 2011. *Crisis Economics: A Crash Course in the Future of Finance*, Penguin, London. 347 p.
- Rumsfeld, D. 2002. DoD News Briefing: Secretary Rumsfeld and Gen. Myers, February 12, 2002. United States Department of Defense.
- Samuelson, P.A. and Nordhaus, W.D. 2010. *Economics*. Nineteenth Edition, McGraw-Hill/Irwin, New York. 715 p.
- Silver, N. 2012. *The Signal and The Noise: The Art and Science of Prediction*. Penguin, London. 518 p.
- Stringer, D. 2015. Australia's Atlas Suspends Output on Iron Ore Price Collapse. Bloomberg, 10 April [online]: <http://www.bloomberg.com/news/articles/2015-04-10/australia-s-atlas-suspends-output-as-iron-ore-price-collapses> [Accessed: 3 July 2015].

- Sykes, J.P., and Trench, A., 2014, Finding the Copper Mine of the 21st Century: Conceptual Exploration Targeting for Hypothetical Copper Reserves, Society of Economic Geologists Special Publication 18, 273-300.
- Taleb, N.N. 2008. *The Black Swan: The Impact of the Highly Improbable*. Penguin, London. 394 p.
- Tetlock, P.E. 2009. *Expert Political Judgment: How Good Is It? How Can We Know?* Princeton University Press, Princeton. 334 p.
- Tett, G. 2009. *Fool's Gold: How Unrestrained Greed Corrupted a Dream, Shattered Global Markets and Unleashed a Catastrophe*. Little Brown, New York. 352 p.
- Trench, A. and Sykes, J.P. 2014. Perspectives on Mineral Commodity Price Cycles and their Relevance to Underground Mining, Proceedings of the 12th AusIMM Underground Operators' Conference, Australian Institute of Mining and Metallurgy. Adelaide, 24-26 March, Pp. 19-31.
- Trench, A., Packey, D and Sykes, J.P. 2014. Chapter 7. Non-Technical Risks and Their Impact on the Mining Industry. Australian Institute of Mining & Metallurgy Monograph 30, Mineral Resource and Ore Reserve Estimation. Second Edition p.605-618.
- Vardi, N. 2013. The Great Gold Collapse. Forbes, 20 June [online]: <http://www.forbes.com/sites/nathanvardi/2013/06/20/the-great-gold-collapse/> [Accessed: 3 July 2015].
- Wack, P. 1985a. Scenarios: shooting the rapids. Harvard Business Review, November-December: 139-150.
- Wack, P. 1985b. Scenarios: uncharted waters ahead. Harvard Business Review, September-October: 73-89.
- Wilkinson, A. and Kupers, R. 2013. Living in the Futures. Harvard Business Review, May: 119-127.
- Wells, H.G. 1898. *The Time Machine*. Project Gutenberg e-Book, October 2, 2004 edition: www.gutenberg.com.