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METALS & MINING

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See Disclosure Appendix of this report for important Disclosures and Analyst Certifications

“Civilisation did not begin until metals became the material of tools, implements, and machines”

T. A. Rickard, “Man and Metals", 1932

"The total volume of workable mineral deposits is an insignificant fraction of the earth's crust, and each deposit represents some geological accident in the remote past, each deposit has its limits; if worked it must be exhausted. No second crop will materialise. Rich mineral deposits are a nation's most valuable but ephemeral material possession."

T.S. Lovering, "Mineral Resources from the Land", 1969.

"Productivity isn’t everything, but in the long run it is almost everything. A country’s ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker."

Paul Krugman, "The Age of Diminishing Expectations", 1994

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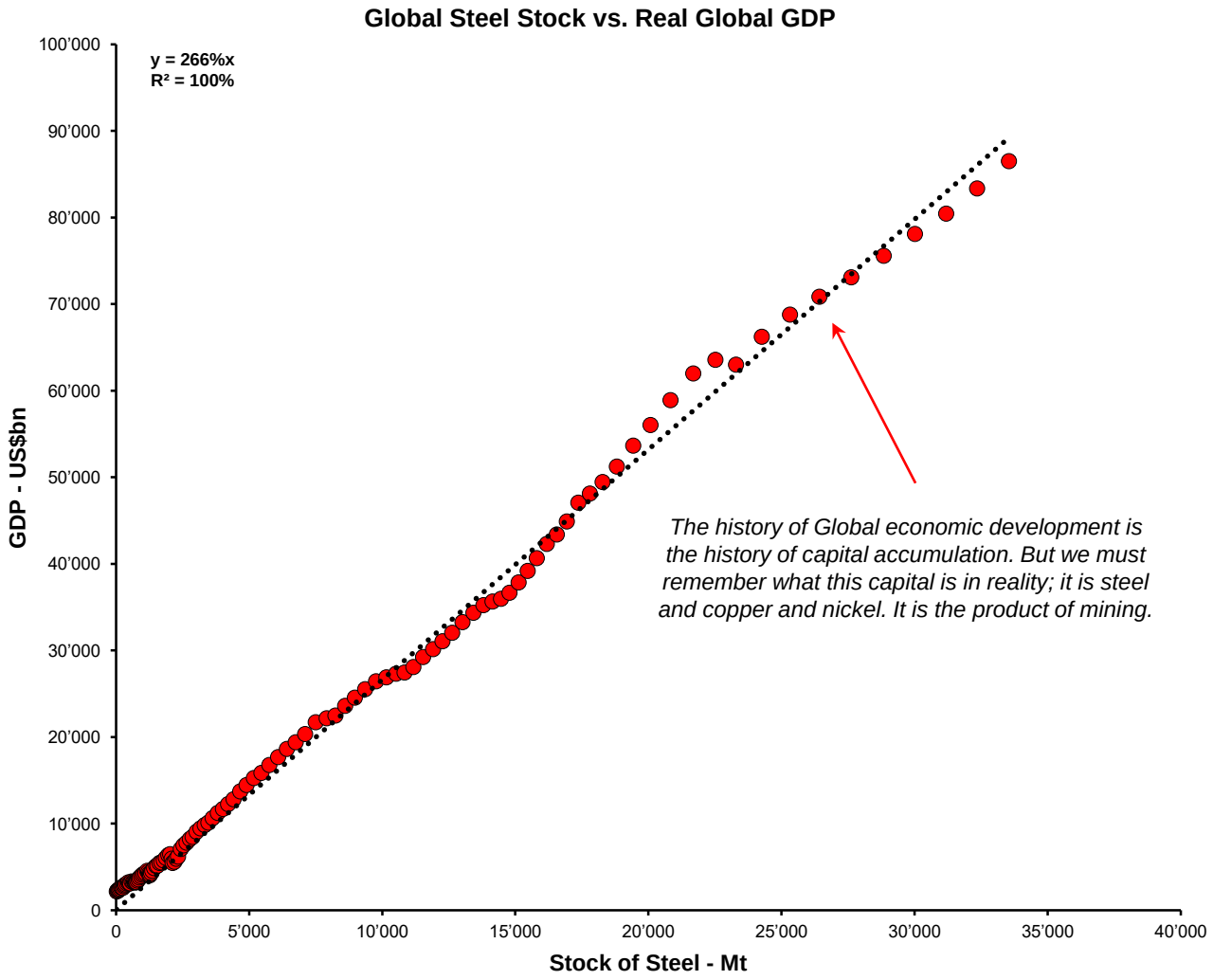
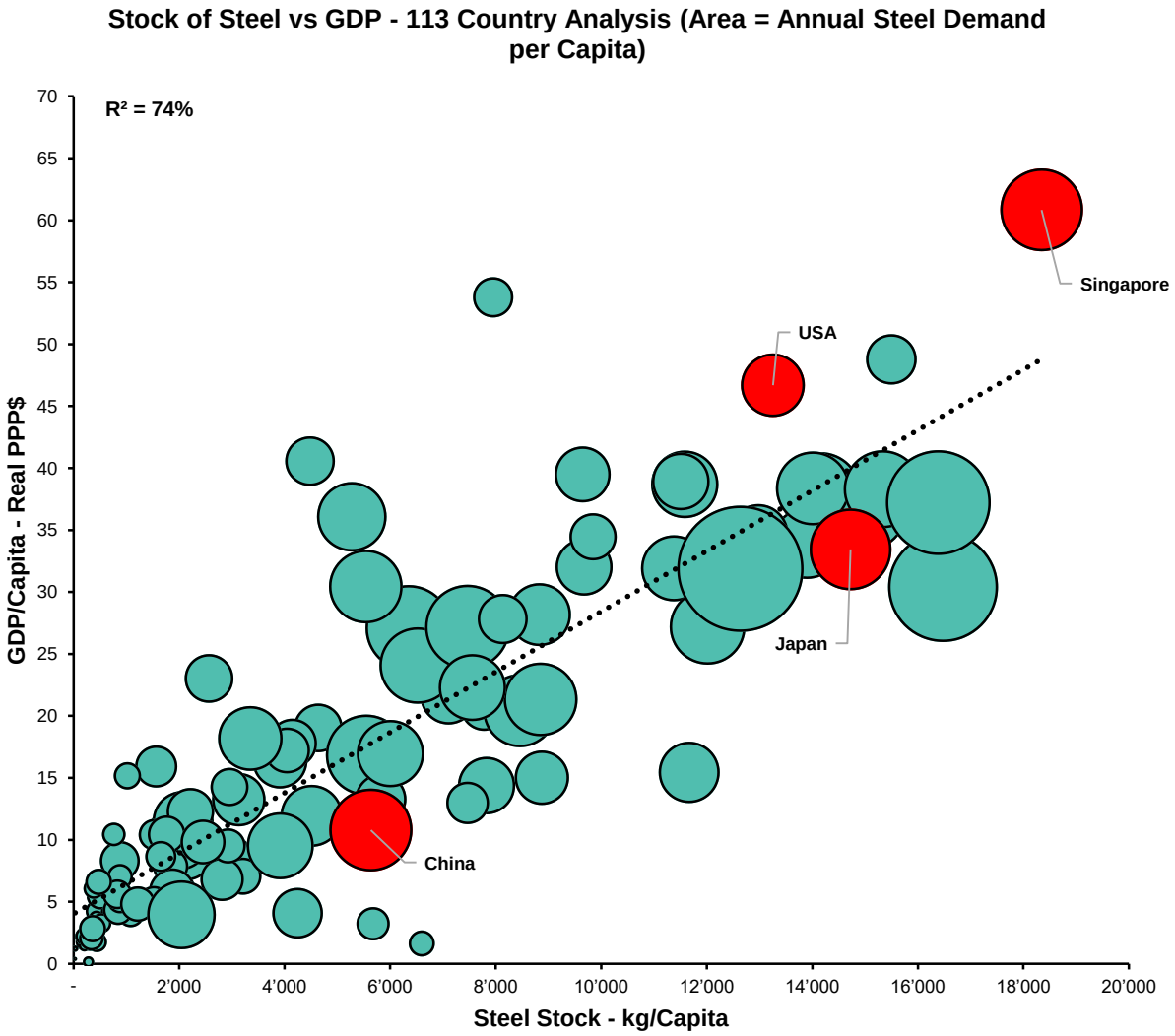
More than any other factor, the mass accumulation of metal is responsible for the form of the modern economy



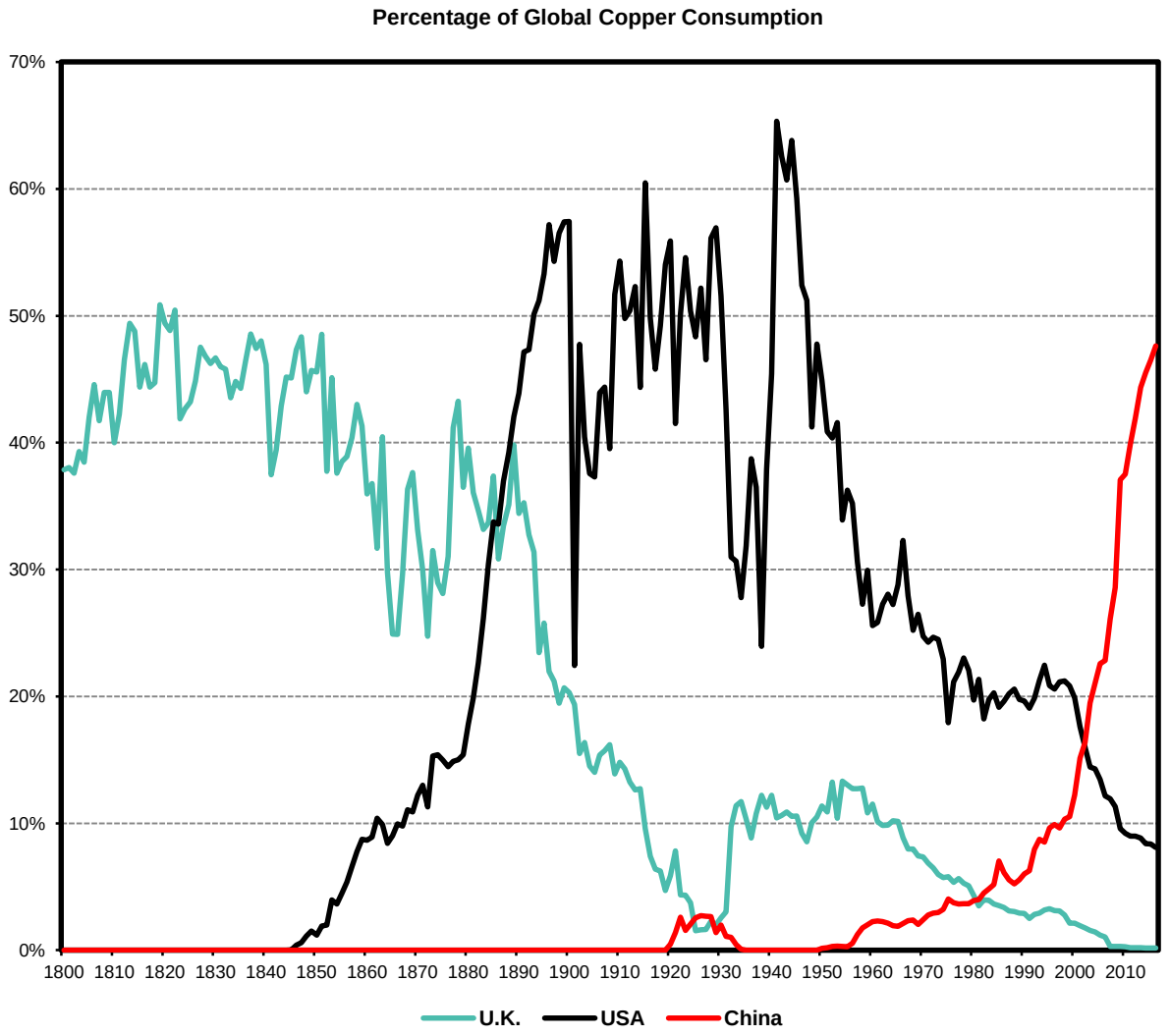
Source: WSA, Mitchell, Maddison, UN, IMF, Bernstein analysis

Indeed, the stock level of metal in any country is probably the most significant factor in determining the levels of prosperity



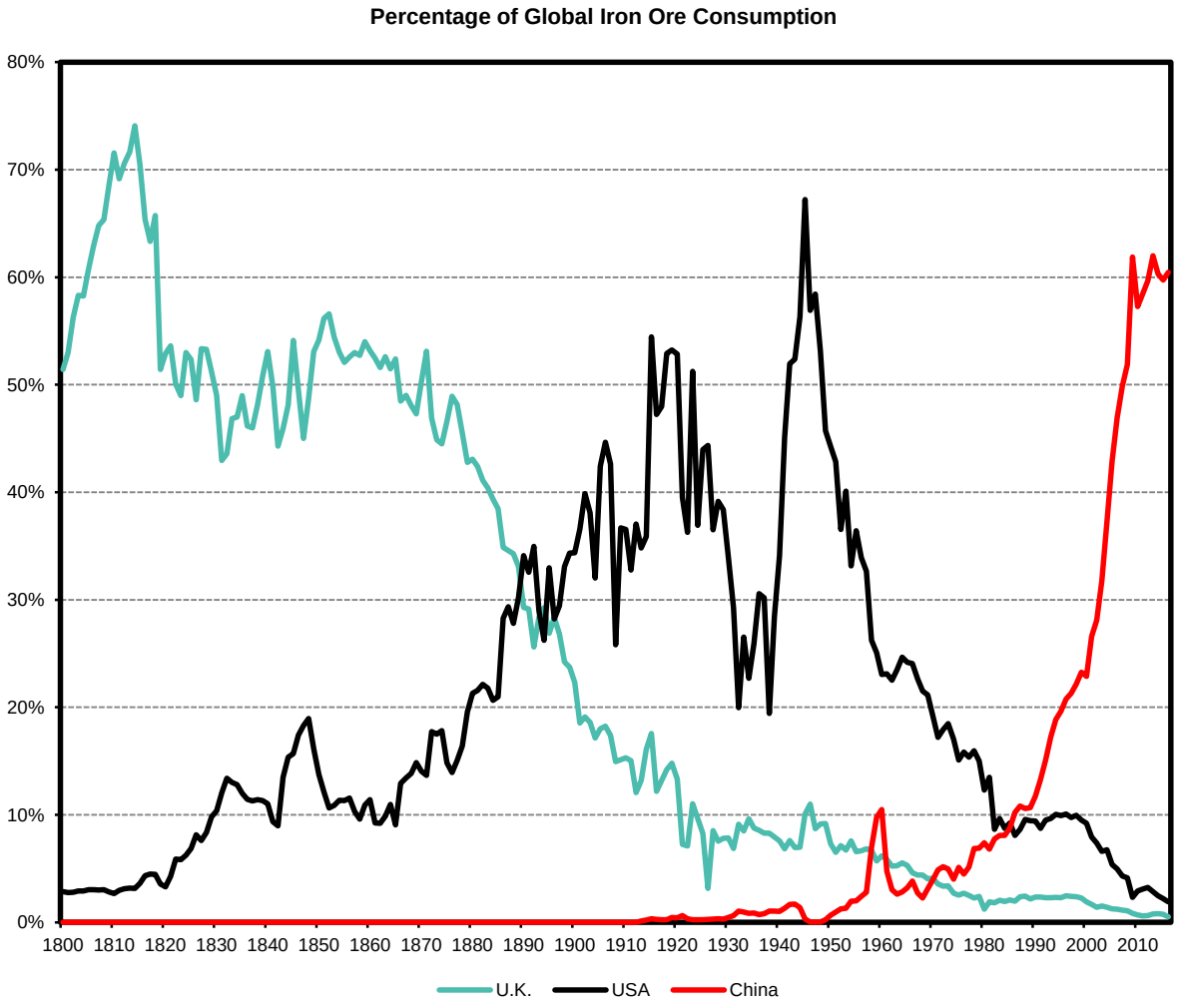
Source: WSA, Mitchell, Maddison, UN, IMF, Bernstein analysis

Moreover, while China's demand is significant, it is far from being anomalous from an historical perspective



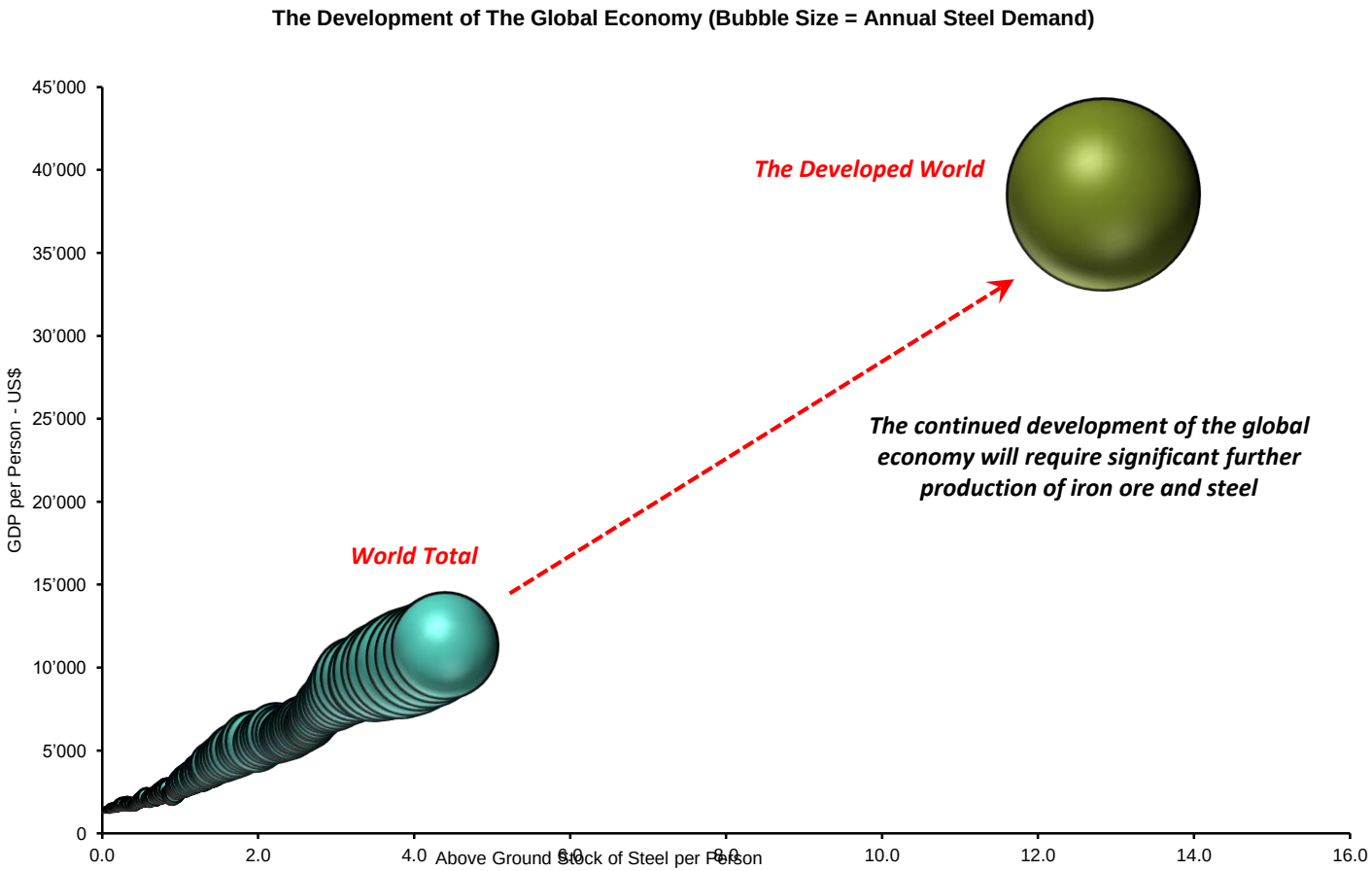
Source: Wood Mackenzie, WBMS, Schmitz, USGS, Mitchell, Bernstein Analysis

And we see exactly the same pattern when we move to iron ore.



Source: Wood Mackenzie, WBMS, Schmitz, USGS, Mitchell, Bernstein Analysis & Estimates

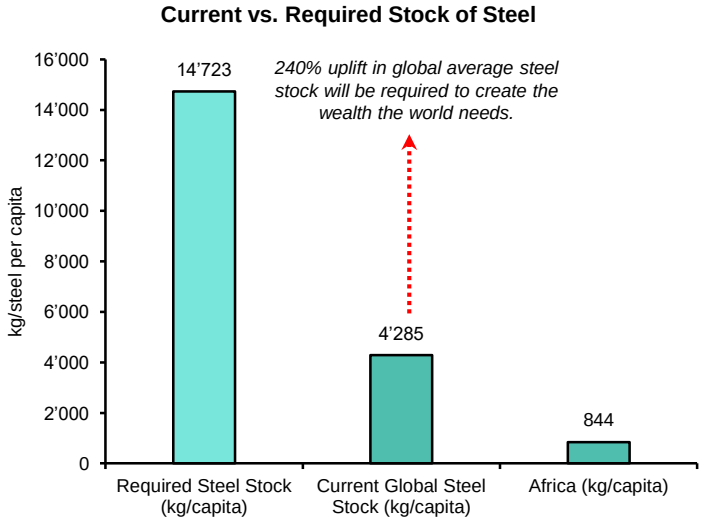
To fulfil global growth ambitions and bridge the gap between countries, the world economy must accumulate more metals.

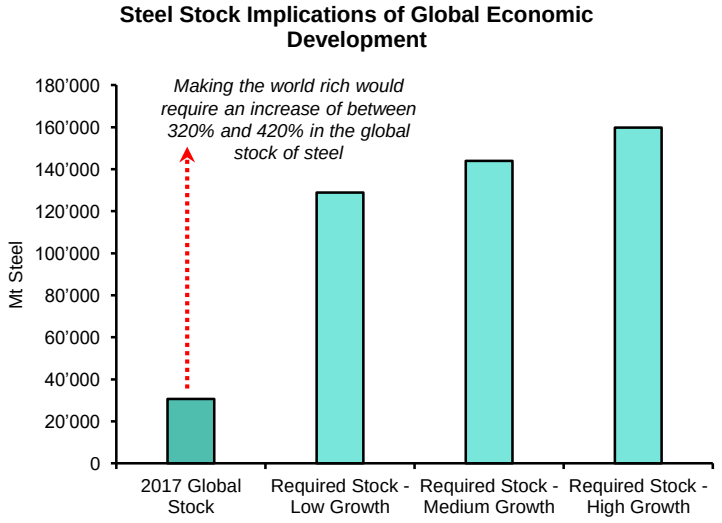


Source: WSA, Mitchell, Maddison, UN, Bernstein analysis and estimates

Achieving the UN's Sustainable Development Goal #1 – "No Poverty"

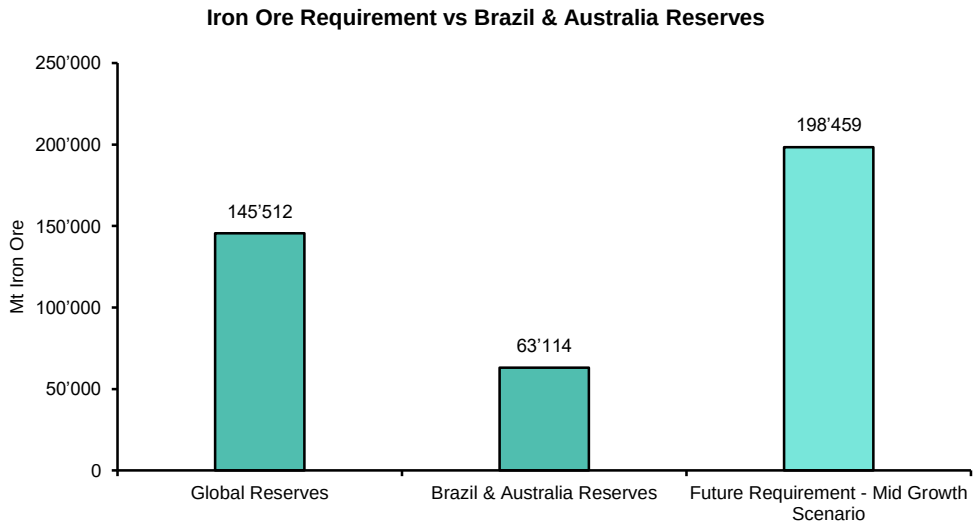
- The current stock of steel in the global economy stands at ~32 billion tonnes. This represents the cumulative total of all the steel production, including recycling, that has taken place since the introduction of the Bessemer process in 1856
- However, this is distributed in a largely uneven manner
  - The 32bn tonnes corresponds to ~4 tonnes per person as a global average
  - However in the West we have ~15 tonnes of steel per person, in most of Africa it is less than 1 tonne
  - In China today it is around 6.5 tonnes
- The creation of wealth is synonymous with the creation of a physical infrastructure capable of supporting human wellbeing
- We estimate that there will be no poverty when each of the world's 9.8bn people (i.e. the medium term, mid-growth case population) have access to the goods and services that can be provided by 15 tonnes of steel
- This equates to a 240% uplift global steel stocks today, and at least a 320% uplift by 2050!

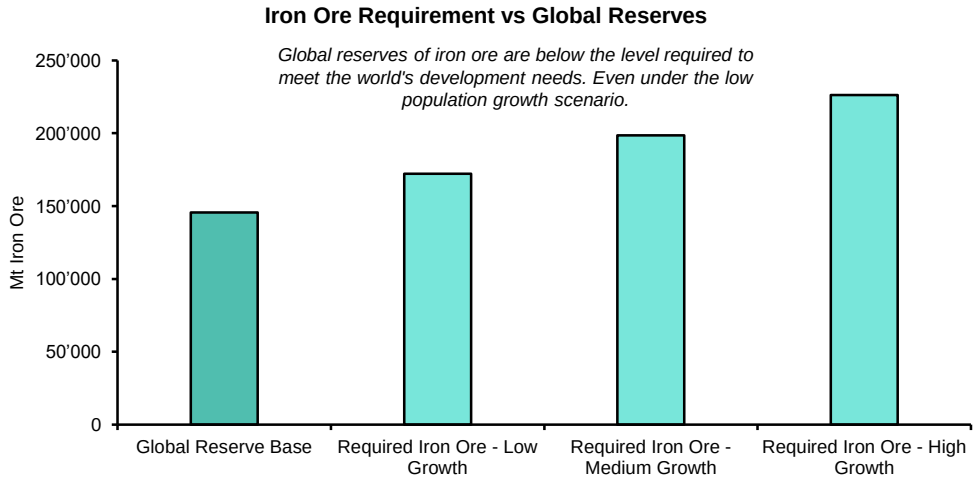




Source: WSA, Mitchell, Maddison, UN, IMF, Bernstein analysis and estimates

This means mining an additional 200 billion tonnes of iron ore





- The reality of achieving this development goal is the extraction of additional 200bn tonnes of iron ore
- However, the total reserves of iron ore in Australia and Brazil are about 63bn tonnes
- The key point we would make is that addressing the problem of economic growth in the face of finite reserves requires investment in and by mining companies
- Thus a prohibitive cost of capital (i.e. low valuations) applied to the mining industry makes this problem far harder to solve and, in the end, impossible
  - This drives are view that miners should be seen as the quintessential ESG stock, rather than their current status a 'sin' stock
- A society that devotes its intellectual energy, and capital, to the creation of new "Apps" is not likely to be one where the claim to desire the end of poverty

Source: WSA, Mitchell, Maddison, UN, IMF, Bernstein analysis and estimates

Our approach to calculating metal (steel) demand growth

- To consider the whole industry, we begin with an analysis of the flow of steel (and move onto stock and scrap later)
- We arrive at our steel demand growth estimates using a simple but powerful and not widely appreciated identity that relates the main macroeconomic variable in an economy to its consumption of steel
- This is a purely analytic expression and must necessarily be true
- What this says:
  - ***The percentage growth (or decline) in steel demand is equal to the percentage growth in population plus the percentage growth in output per person (GDP per capita) plus the percentage growth rate in steel intensity (i.e. kilogrammes of steel per thousand dollars of GDP).***

$$Steel = \frac{Steel}{GDP} \cdot \frac{GDP}{Population} \cdot Population$$

$$Steel = SI \cdot G \cdot P$$

$$dSteel = dSI \cdot G \cdot P + dG \cdot SI \cdot P + dP \cdot SI \cdot G$$

$$\therefore \frac{dSteel}{Steel} = \frac{dSI}{SI} + \frac{dG}{G} + \frac{dP}{P}$$

$$\%Steel = \%SI + \%G + \%P$$

Source: Bernstein Analysis

Analysing a century of growth in the demand for steel.

Global Steel CAGR	SI	GDP/Cap	Pop.	Steel
1900-1910	4.9%	1.8%	1.1%	7.8%
1910-1920	0.9%	0.5%	0.7%	2.0%
1920-1930	-0.6%	2.1%	1.1%	2.6%
1930-1940	2.1%	1.3%	1.0%	4.4%
1940-1950	0.2%	1.5%	1.0%	2.7%
1950-1960	1.6%	2.9%	1.9%	6.5%
1960-1970	0.6%	3.2%	2.0%	5.7%
1970-1980	-1.4%	1.8%	1.9%	2.3%
1980-1990	-1.5%	0.9%	1.7%	1.1%
1990-2000	-1.2%	1.5%	1.4%	1.7%
2000-2010	2.0%	2.2%	1.3%	5.5%
2010-2017	-0.5%	2.1%	1.2%	2.8%
1900-2017	**0.6%**	**1.8%**	**1.4%**	**3.8%**

Source: WSA, Mitchell, Maddison, UN, IMF, Bernstein analysis

Based on the UN population and IMF/World Bank GDP forecasts, the lowest historical steel intensity decline rate would still yield a steel demand growth rate of 1.9% to 2030! And the highest gives 5.5%!

Top Down Global Steel	Source	2017-2030 Min	2017-2030 Max	
Population	UN	1.0%	1.0%	***As per latest UN Forecasts***
GDP/Capita	IMF/World Bank	2.5%	2.5%	***IMF/World Bank***
Steel Intensity	Global min/max	-1.5%	2.0%	***Min/Max Range for Trend Global Steel Intensity***
Steel Demand		**1.9%**	**5.5%**	

Source: WSA, Mitchell, Maddison, UN, IMF, Bernstein analysis

How can we estimate what long run metal/steel intensity (SI) should be?

- Of course, we have fairly robust estimates for both population and GDP growth, therefore the variable of interest for us is steel intensity
- The economic insight...as Karl Marx would have it (Das Kapital): *"The wealth of those societies in which the capitalist mode of production prevails, presents itself as an immense accumulation of commodities"*
- **Steel is the capital stock of the modern industrial economy...it is the material basis upon which everything else is predicated, this being so we can avail ourselves of the apparatus of neo-classical economic theory (and in particular the AK model)**
  - ***The steady state metal intensity of an economy is proportional to the rate of capital depreciation plus the level of economic growth.***

$$G = V \cdot Q$$

$$\frac{dG}{dt} = V \cdot \frac{dQ}{dt}$$

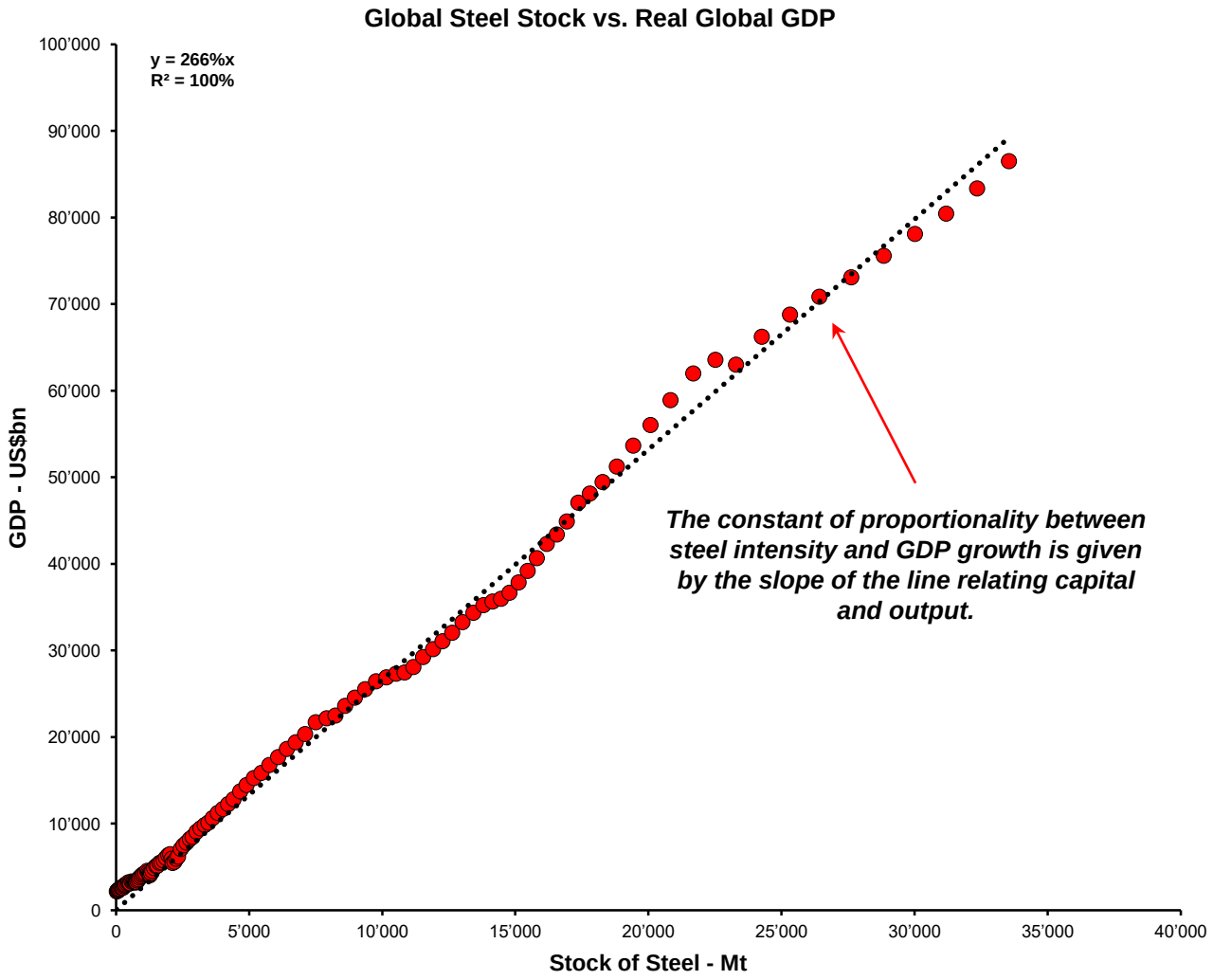
$$\frac{dQ}{dt} = \alpha \cdot S - \beta \cdot Q$$

$$\therefore \frac{dG}{dt} = V \cdot (\alpha \cdot S - \beta \cdot Q)$$

$$\frac{dG/_G}{dt} = \alpha V \cdot \frac{S}{G} - \beta$$

$$\therefore SI = \frac{1}{\alpha \cdot V} \cdot (\%GDP + \%Dep)$$

The importance of the world's physical capital?



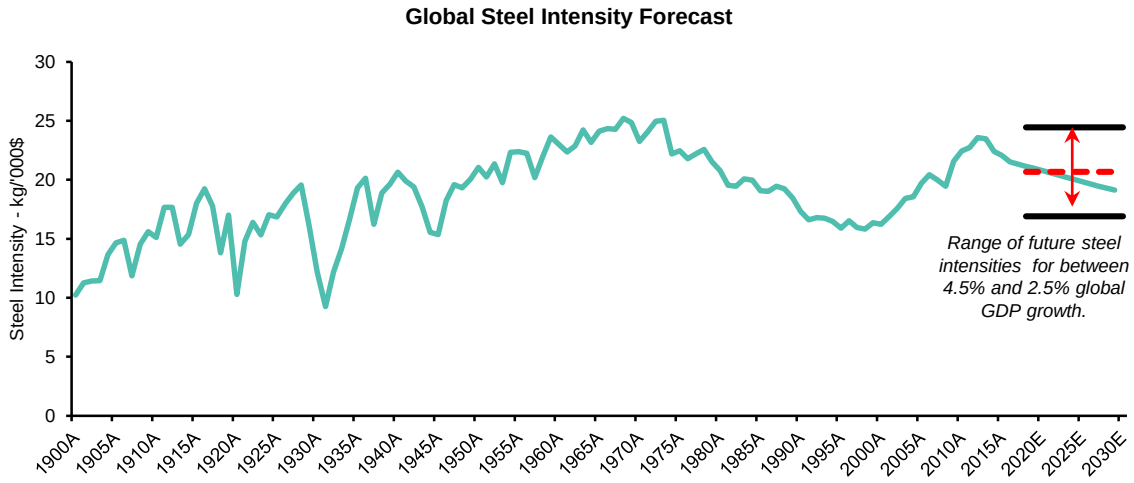
Source: WSA, Mitchell, Maddison, UN, IMF, Bernstein analysis

Using our steady-state framework to forecast steel intensity

+ We use our steady-state relationship to estimate a level of steel intensity (SI) going forward

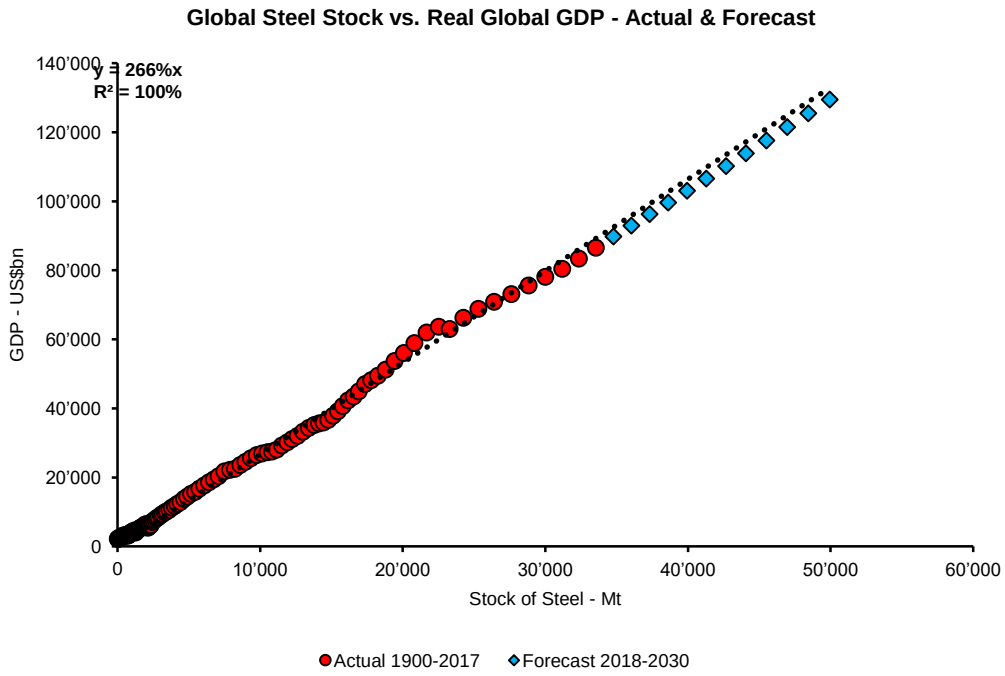
$$\therefore SI = \frac{1}{\alpha \cdot V} \cdot (\%GDP + \%Dep)$$

Calculating Global Steel Intensity		Low Growth	Mid Growth	High Growth
Global "Velocity" of Steel (V)	000US$/t	2.7	2.7	2.7
1/V	t/'000US$	0.4	0.4	0.4
Global GDP Growth Rate (a)	%	2.5%	3.5%	4.5%
Depreciation (b)	%	2.0%	2.0%	2.0%
Steel Intensity (1/V*(a+b))*1000	kg/'000$	16.9	20.7	24.4
Current Steel Intensity	kg/'000$	21.5	21.5	21.5
Implied SI CAGR	**%**	**(1.8%)**	**(0.3%)**	**1.0%**



Source: WSA, Mitchell, Maddison, UN, IMF, Bernstein analysis and estimates

So, what does the future hold?



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Steel Intensity (1/V*(a+b))*1000	kg/'000$	16.9	20.7	24.4
Current Steel Intensity	kg/'000$	21.5	21.5	21.5
Implied SI CAGR (c)	%	(1.8%)	(0.3%)	1.0%
Population CAGR (d)	%	0.9%	0.9%	0.9%
GDP/Capita CAGR (e)	%	1.6%	2.6%	3.6%
Steel Demand Growth Rate (c+d+e)	**%**	**0.7%**	**3.2%**	**5.5%**

Source: WSA, Mitchell, Maddison, UN, IMF, Bernstein analysis and estimates

- Once we know the steel intensity that is required for any level of economic growth, and we also know the current level of steel intensity, then we can calculate the percentage change in steel intensity that is required to ensure that we do not depart from the historically observed stock to output relationship
- Given that we know the percentage change in steel intensity, we use our equation to calculate future steel demand growth
- This decomposition also shows us that the second derivative of GDP is just as important as the first when it comes to determining the growth in steel (or any metal) demand!
  - Of course, this also explains why recessionary shocks (as seen in 2015/2016) are so often misunderstood

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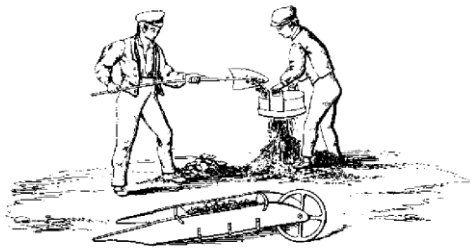
The World Of Mining As it Used To Be…



RIDDLING.

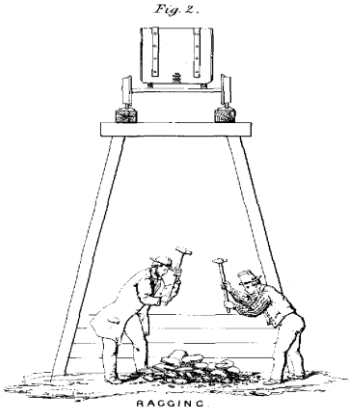


Fig. 2.

RAGGING.

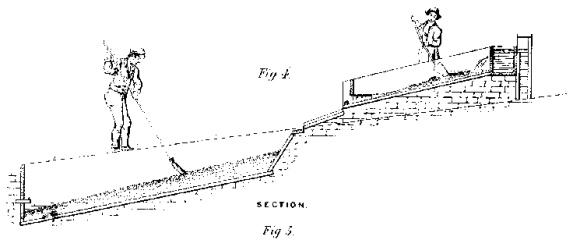


Fig 4.

SECTION.

Fig 5.

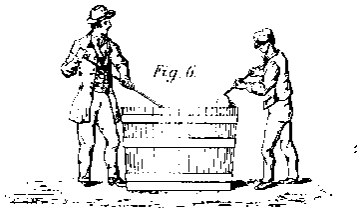


Fig. 6.

TOSSING.

Fig. 3.

SPALLING.

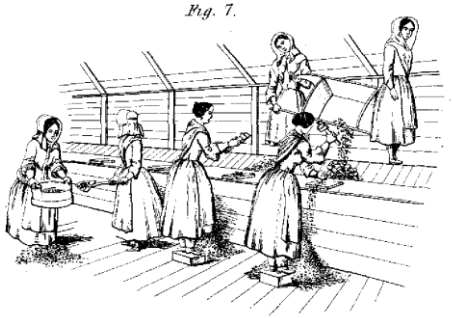


Fig. 7.

BUCKING MILLS.

COBBING.

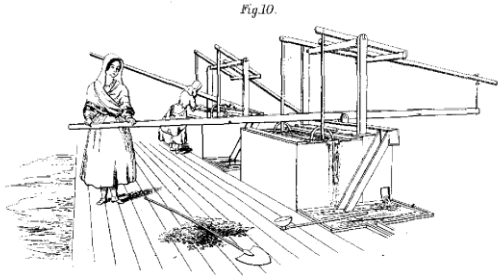


Fig.10.

JIGGING MACHINE.

Source: Henderson and *1858 Proceedings of the Institution of Civil Engineers*.

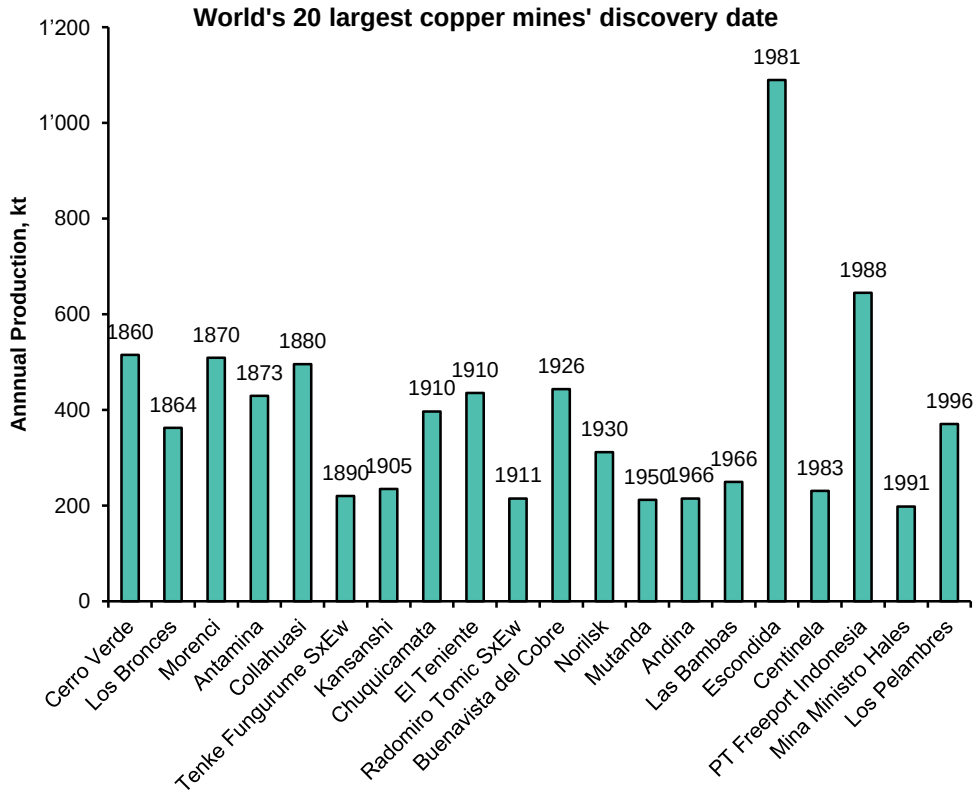
Open Pit Mining: The Bingham Canyon copper mine in the United States

Source: Corporate website.

Scale in mining…the same as the fleet used at Bingham.

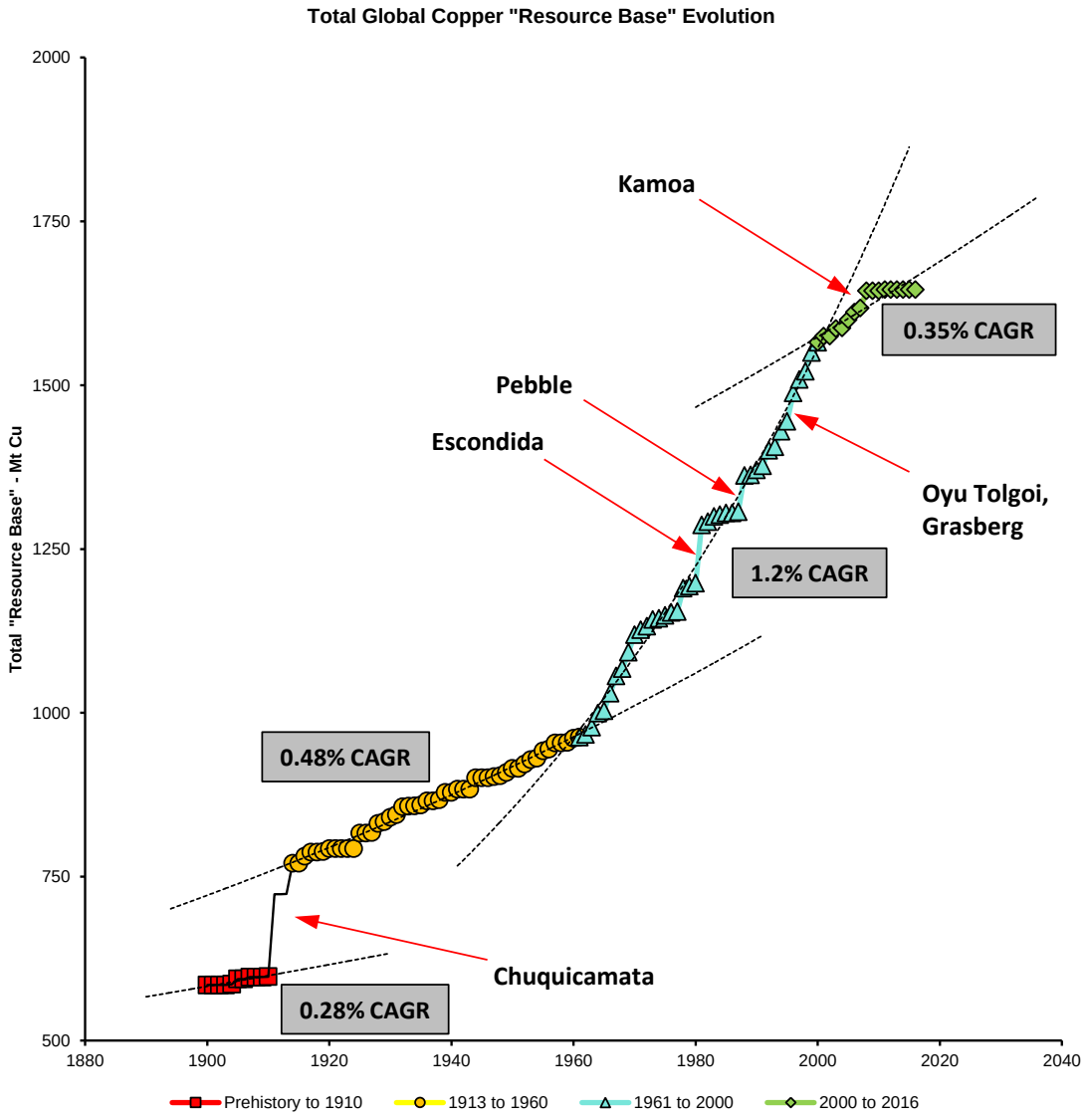
It was our great-grandfathers that built today's copper industry

Mine	Annual Production	Discovery Year
Cerro Verde	515	1860
Los Bronces	363	1864
Morenci	509	1870
Antamina	430	1873
Collahuasi	496	1880
Tenke Fungurume SxEw	220	1890
Kansanshi	235	1905
Chuquicamata	397	1910
El Teniente	436	1910
Radomiro Tomic SxEw	215	1911
Buenavista del Cobre	444	1926
Norilsk	312	1930
Mutanda	212	1950
Andina	215	1966
Las Bambas	250	1966
Escondida	1,090	1981
Centinela	231	1983
PT Freeport Indonesia	645	1988
Mina Ministro Hales	199	1991
Los Pelambres	371	1996
Weighted Average Discovery Year		**1928**



Source: Wood Mackenzie, USGS and Bernstein analysis

The development of the world's copper resource base



+ The chart shows the growth in the global copper resource base…it shows the increase in total estimated in situ copper as we now know the deposit rather than at the time of discovery. For example at Chuqui…

+ ***Deposit is over 6,500 ft long by several hundred feet wide. Number of holes drilled 38. Average thickness of ore developed 404ft, most of holes being stopped in ore. Three are over 1,000ft and still in ore, giving indication of large increase in tonnage. An estimate of reserves April 5 1913 95,657,000 tons averaging 2.41 per cent"***

A little while later the following revision was made

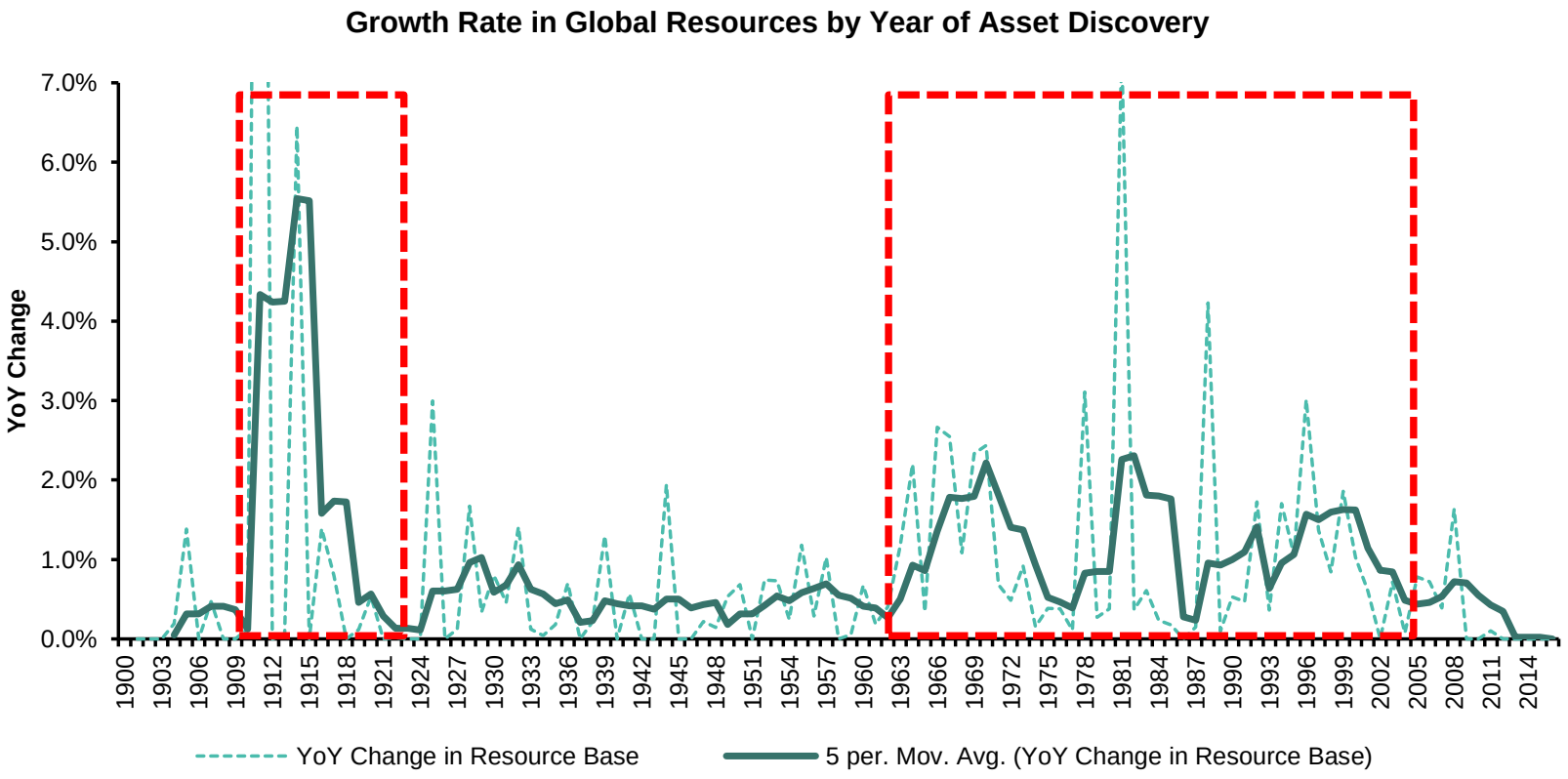
+ ***"The developed ore reserves as of September 1 1914, amounted to 280,855,000 tons averaging 2.13% copper. The development to date has shown a length of about 7,000ft, an average width of over 800ft and a maximum width of 1,555ft. Neither the full width nor the depth have yet been determined. Total holes drilled – 57; average depth of ore over 500ft; 9 holes are over 1,100ft deep and still in ore, the lowest sections of these holes being in ore considerably above average grade."***

Fast forward a hundred years to today

+ ***"Chuquicamata is a tertiary porphyry copper deposit with minor molybdenum. The orebody spans 750m x 3,000m on the surface and extends to a depth of at least 1,000m. The PND 2014 reports for the Chuqui Division resources of 9340 Mt with an average grade of 0.54%CuT at a cut off grade of 0.2% including resources of the Chuqui mine, Cluster Toqui, ENMS and Mina Sur Cola.***

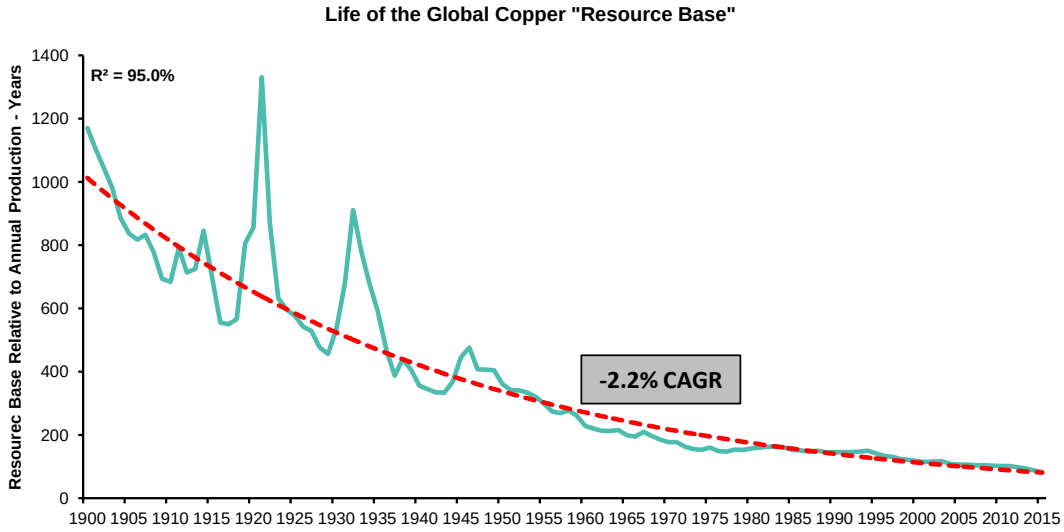
Source: Wood Mackenzie, USGS corporate reports and Bernstein analysis

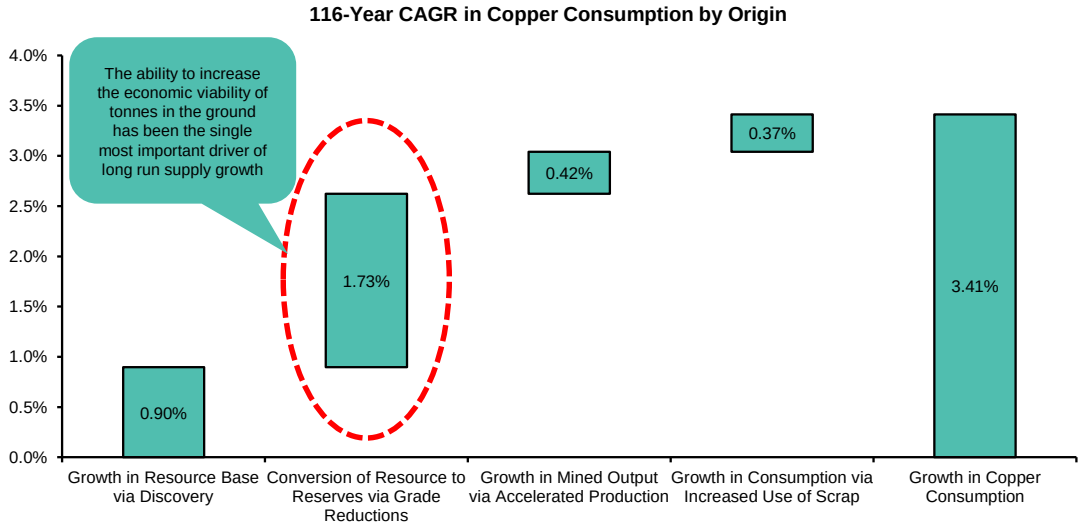
The rate of discovery appears to be slowing…



Source: USGS, Wood Mackenzie, corporate reports, and Bernstein estimates and analysis

Resource life vs. reserve life…how have we been able to grow output? It is all about productivity...

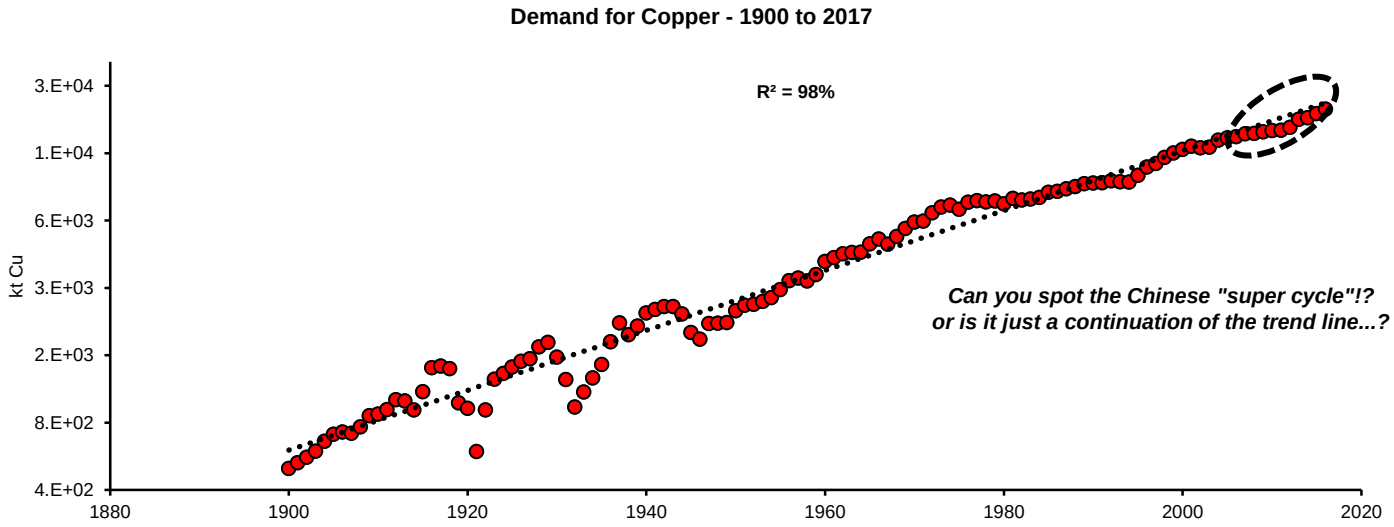


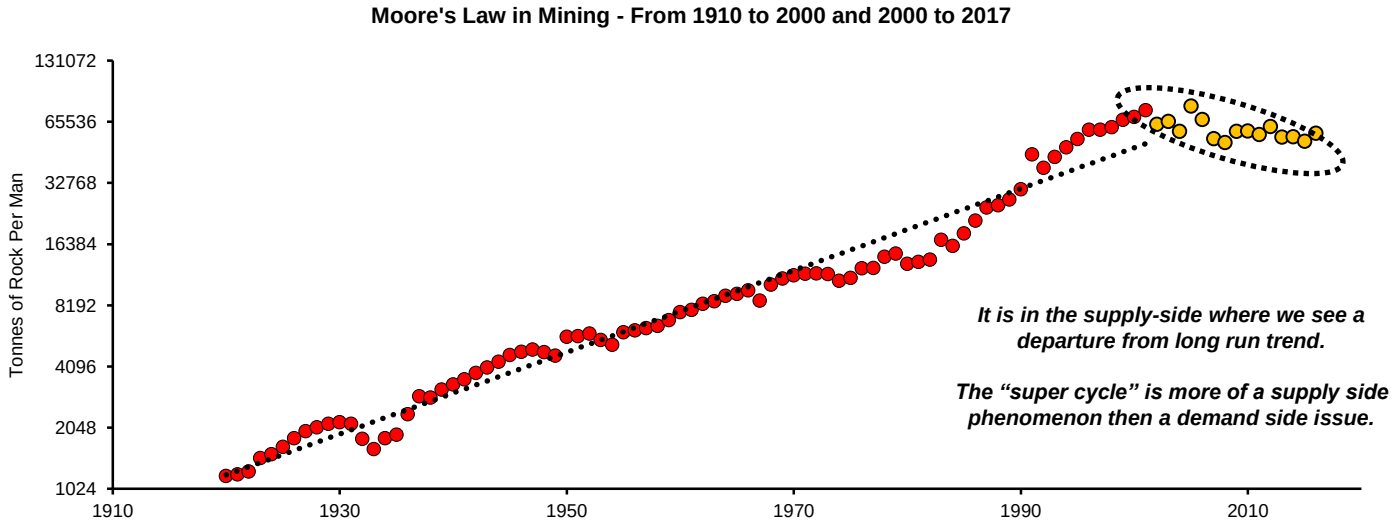


- Almost by definition the reserve life of any commodity is ~20 to 30 years, as this is the NPV maximising LOM.
- The growth in the resource base appears to have been much slower than the growth in output in copper, meaning that the majority of the growth in output has come from resource to reserve conversion. And this process is driven by the interplay between productivity and price.
- The resource life tells an interesting picture…never before in human history has the depletion rate of the existing asset base been as high as it is today, yet the replenishment rate of the resource base is slowing.
- So how do we square decelerating productivity in mining with a slowing rate of asset replacement and a record high level of depletion and a falling commodity price?

Source: USGS, Wood Mackenzie, Schmitz, corporate reports, and Bernstein estimates and analysis

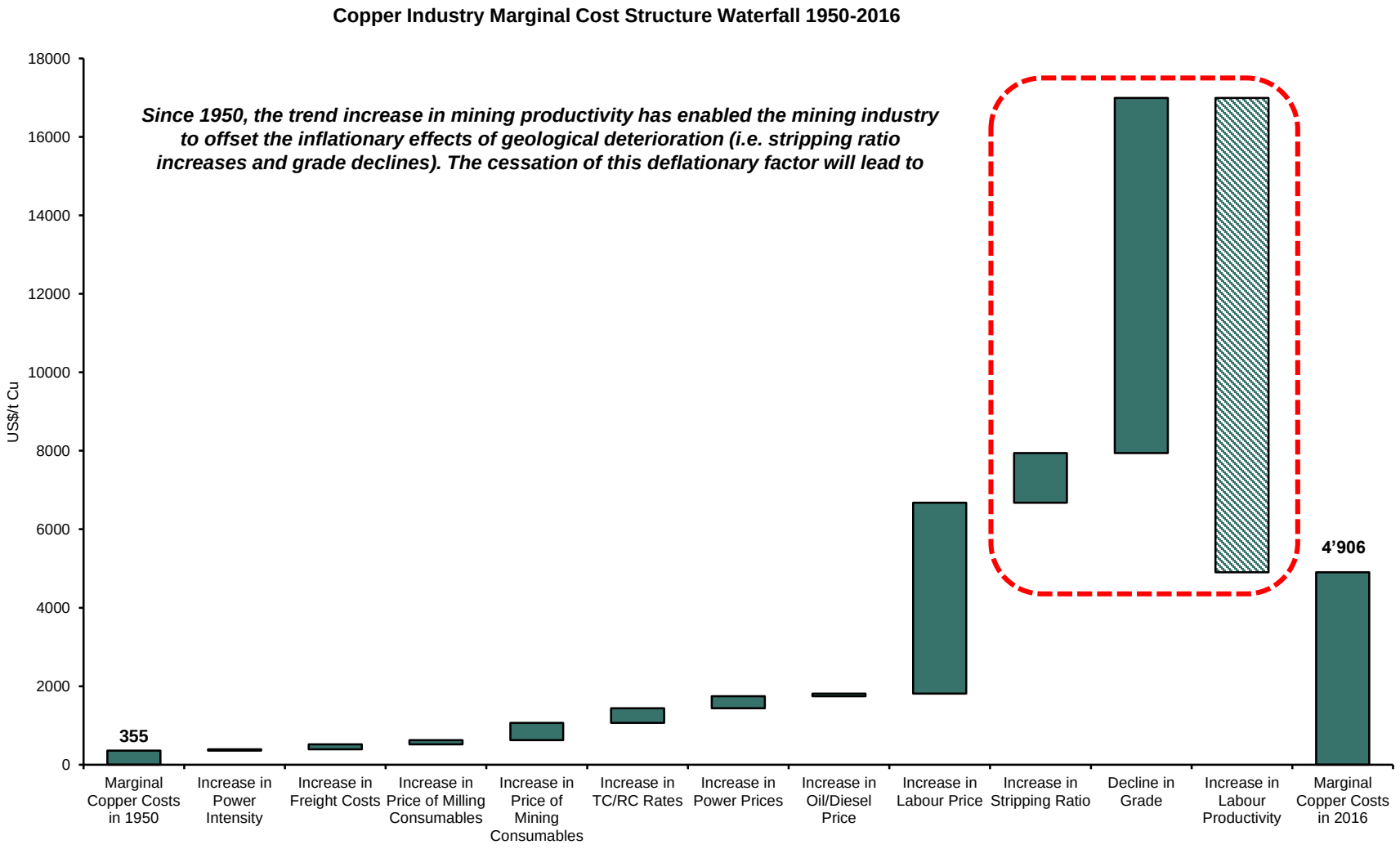
Analysing productivity...the breakdown of “Moore’s Law in Mining”





Source: Wood Mackenzie, USGS, Schmitz, BLS, Corporate Reports, Bernstein Analysis & Estimates

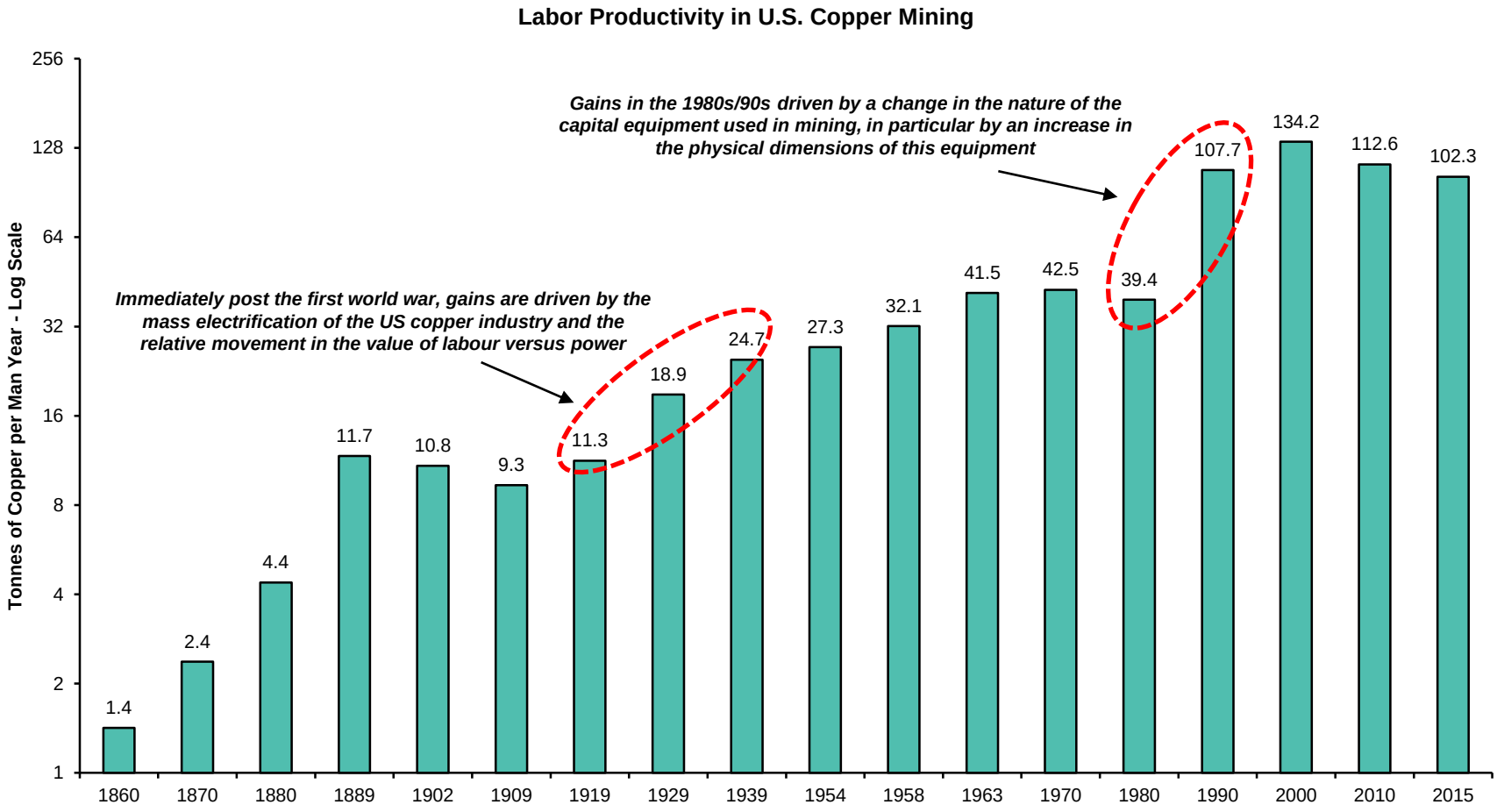
Labour productivity gains have helped to offset the cost inflation coming from geological deterioration



Source Maddison, World Economics; Mitchell, International Historical Statistics; Schmitz, World Non-Ferrous Metal Production; ICSG and Bernstein analysis:

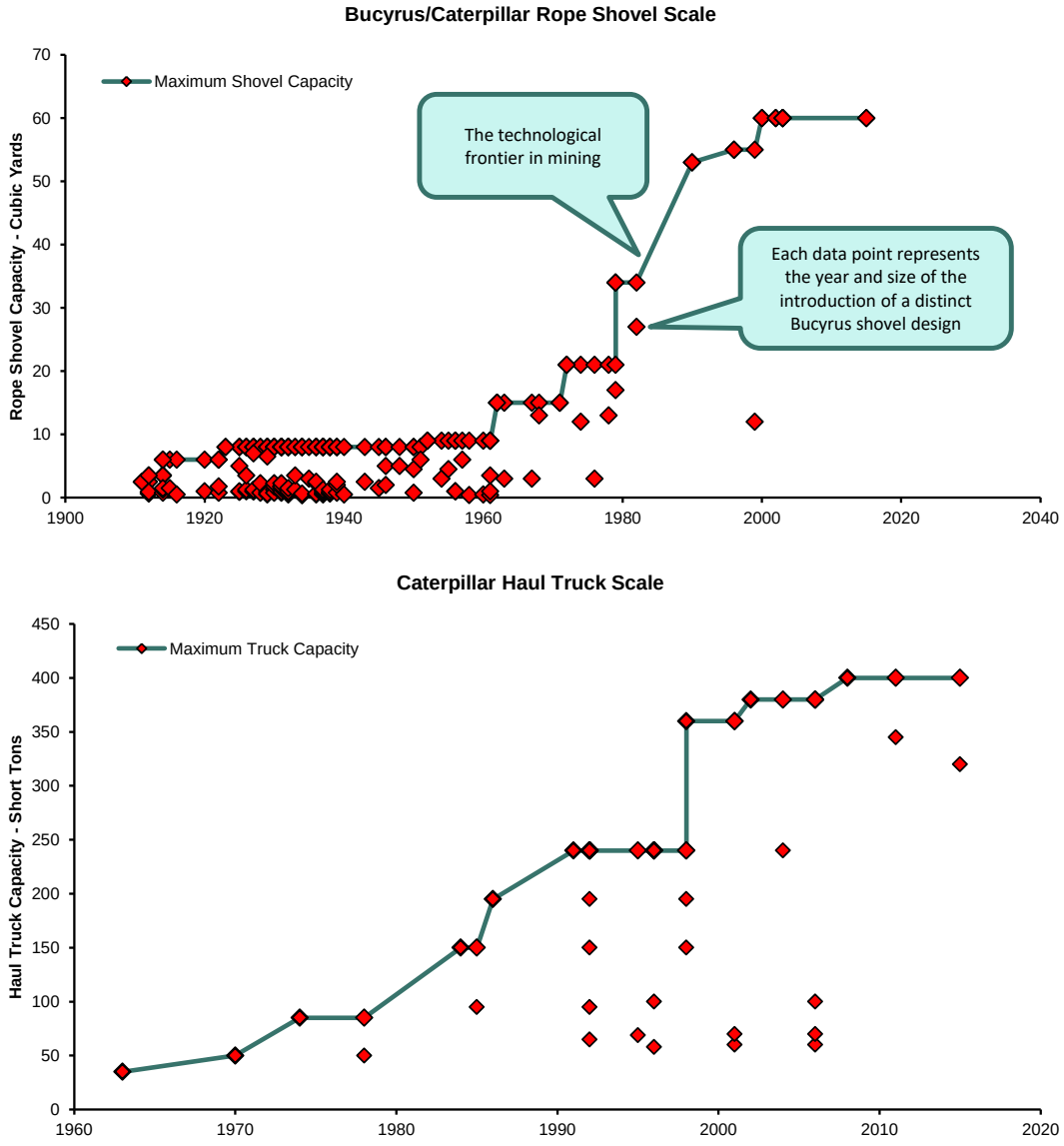
Labour productivity gains are not gradual

+ Considering the long run data on labour productivity, we see extended periods of stasis punctuated by infrequent bursts of activity that radically alter the competitive landscape.



Source: Maddison, World Economics; Mitchell, International Historical Statistics; Schmitz, World Non-Ferrous Metal Production; ICSG and Bernstein analysis

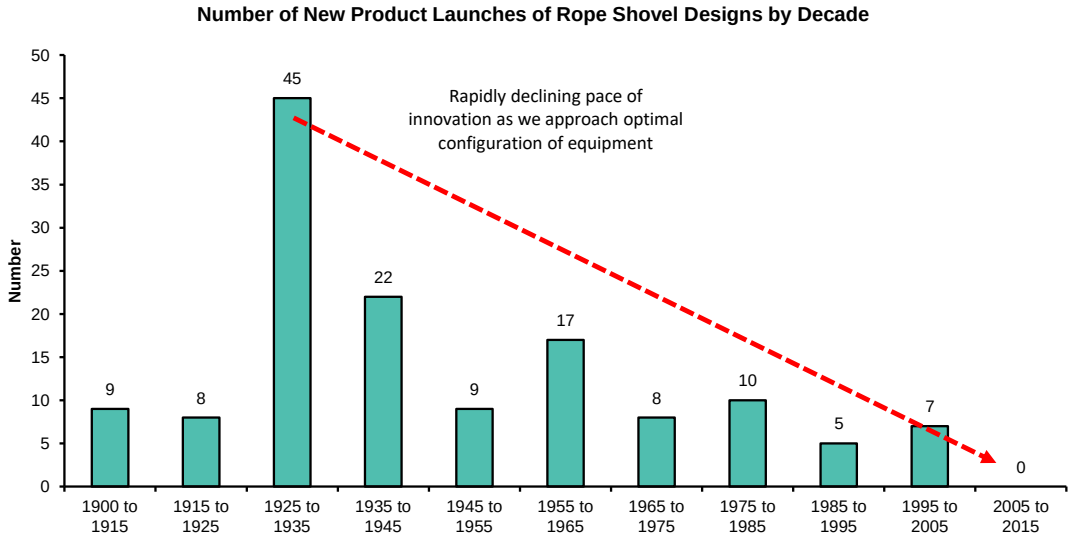
The History of Scale in Mining Equipment

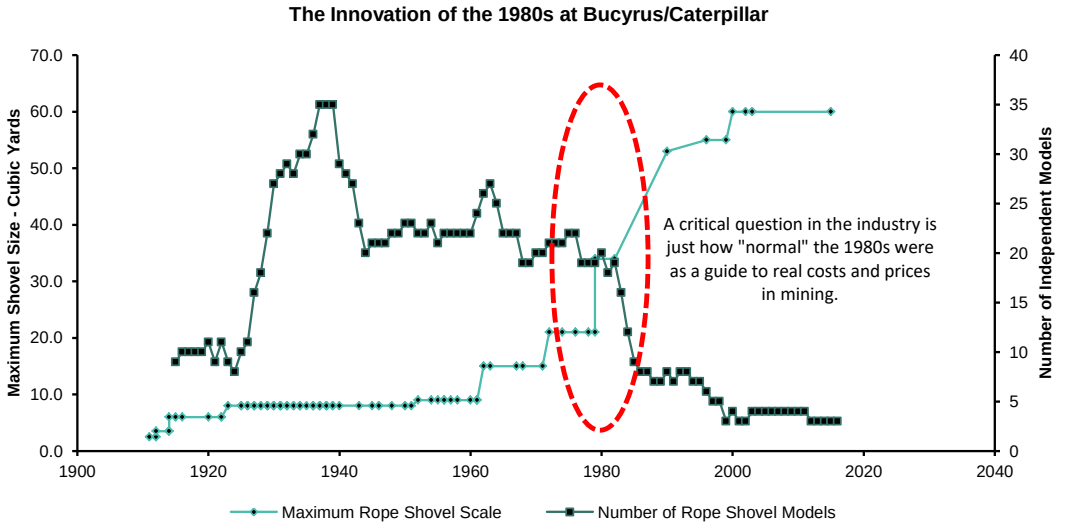


- The two charts of the left show a history of the mining capital equipment offered by Bucyrus/Caterpillar over the last century.
- We look at two items, Rope Shovels (and their steam shovel predecessors) as well as specialist mining haul trucks.
- Each dot in the scatter plots represents the introduction of new model of either truck or shovel. The scatter plot then shows the size of the equipment versus the time of introduction. The line shows and “efficient frontier” being the technological limit of the equipment that is available to the industry.
- As the scale of mining equipment increases the requirement for labour decreases, thus we double the size of the trucks in the mining fleet and we halve the number of drivers required per tonne of ore.
- Again we see productivity as the action of capital (mechanisation) displacing labour as a factor in production.

Source: Corporate reports, and Bernstein estimates (2016-40) and analysis.

The End of Innovation? No, But It Will Get Harder.

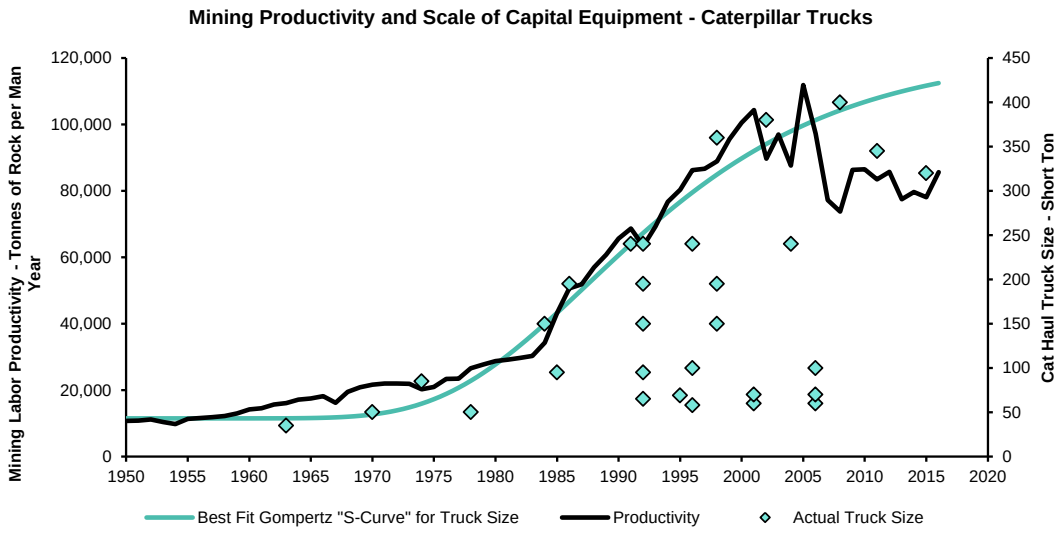


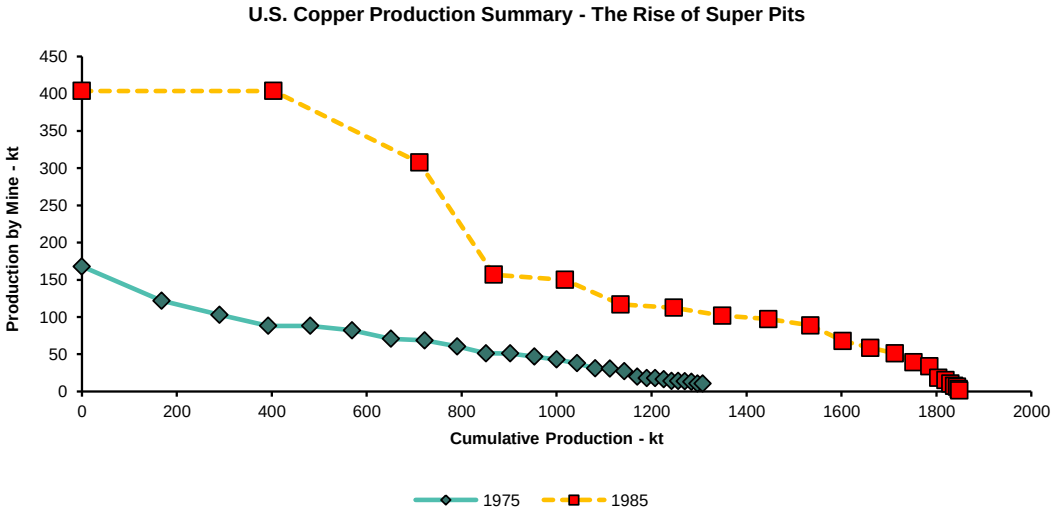


- We then conduct a further piece of analysis for these capital items. In this we look at the total number of different designs on the market at any one point. So we look at when the design was introduced and when it was withdrawn.
- We then look at the number of new design launches by decade. What this analysis highlights is that the period of technical innovation in mining capital equipment, at least as far as simple scale is concerned, is behind us.
- While not a fan of biological metaphors, it appears that the adaptations to the nature of capital equipment employed have reached something of an evolutionary dead end.

Source: Wood Mackenzie, and Bernstein analysis

The 1980s Deflation Explained…

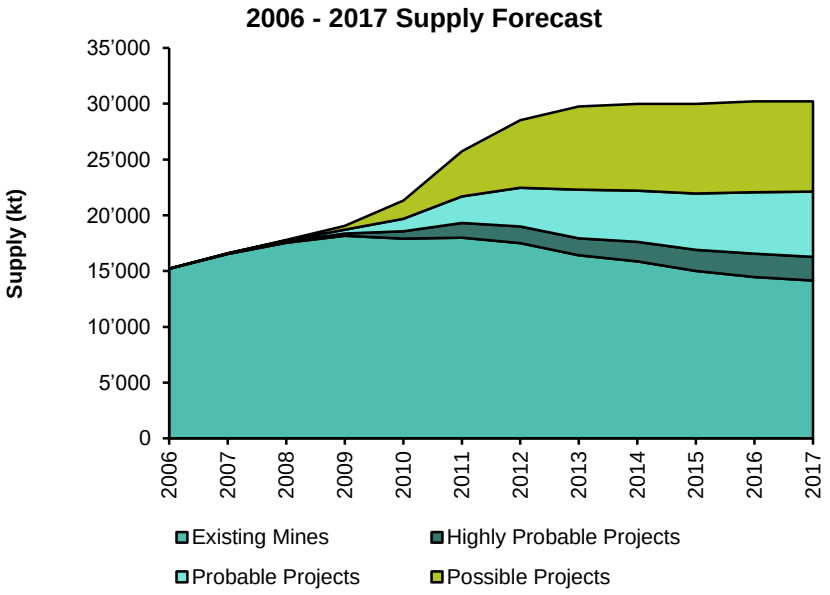


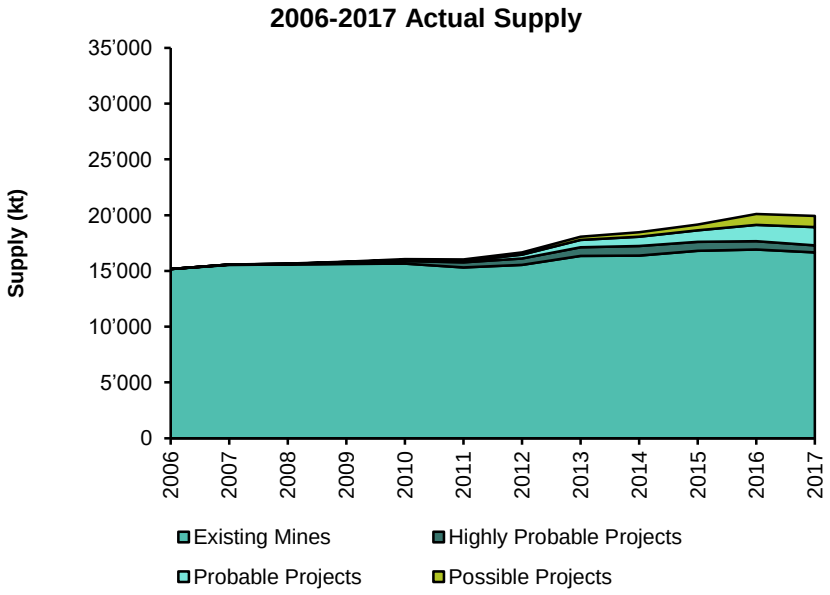


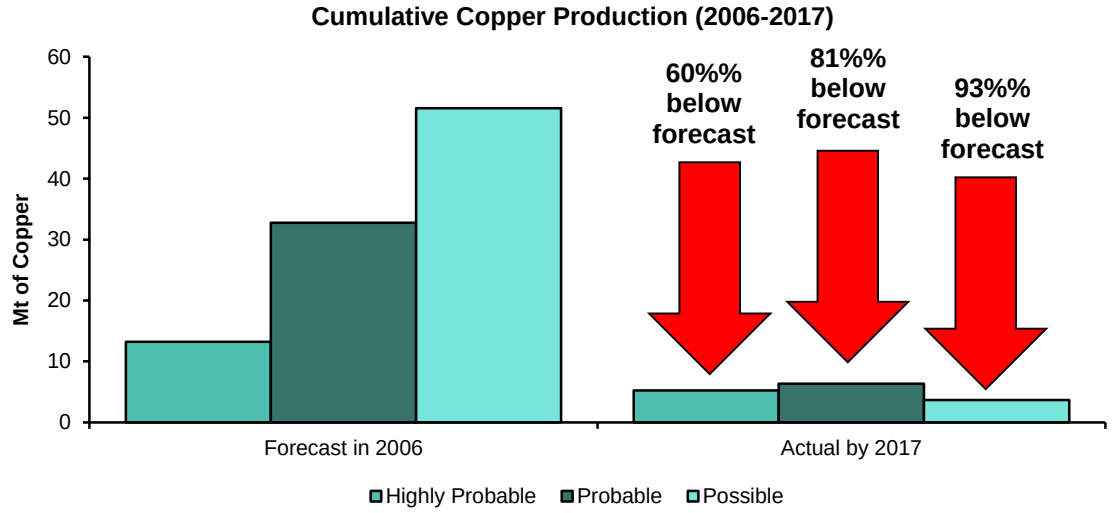
- If we look at the productivity of the mining industry over the 1980s and 1990s we see a truly dramatic increase, the tonnes of rock (ore and waste) moved per man year of labour underwent a tectonic shift.
- Thus mining was able to keep costs flat in nominal terms as the increases in productivity more than offset the inflationary increases in the prices of the factor inputs into mining. Thus in real terms costs fell and the price of commodities tracked the cost structure down.
- But we can now see the driver of the deflationary productivity gain writ large in the scale of the equipment being used on the mines. Labour became more efficient due to the vast increase in the size of mining equipment.
- At the same time, the increase in the scale of mining equipment drove both a consolidation of the mining industry and an increase in the size of mines. Those mines with the geology to take advantage of the new technology grew while those that could not shut.

Source: U.S. Census, BLS, Schmitz, Wood Mackenzie, corporate reports, and Bernstein analysis.

So what about the ever-present “wall of supply”?

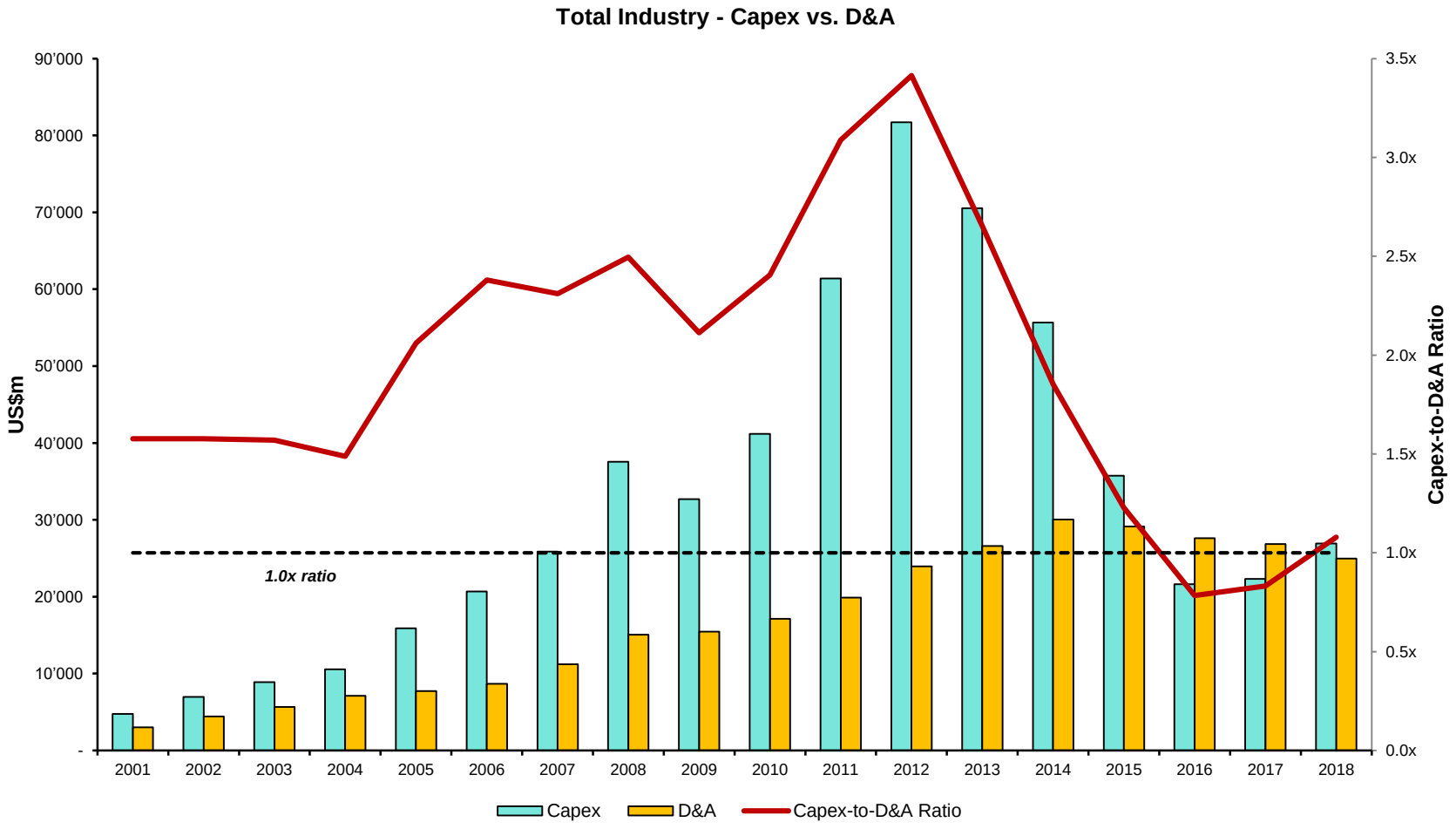




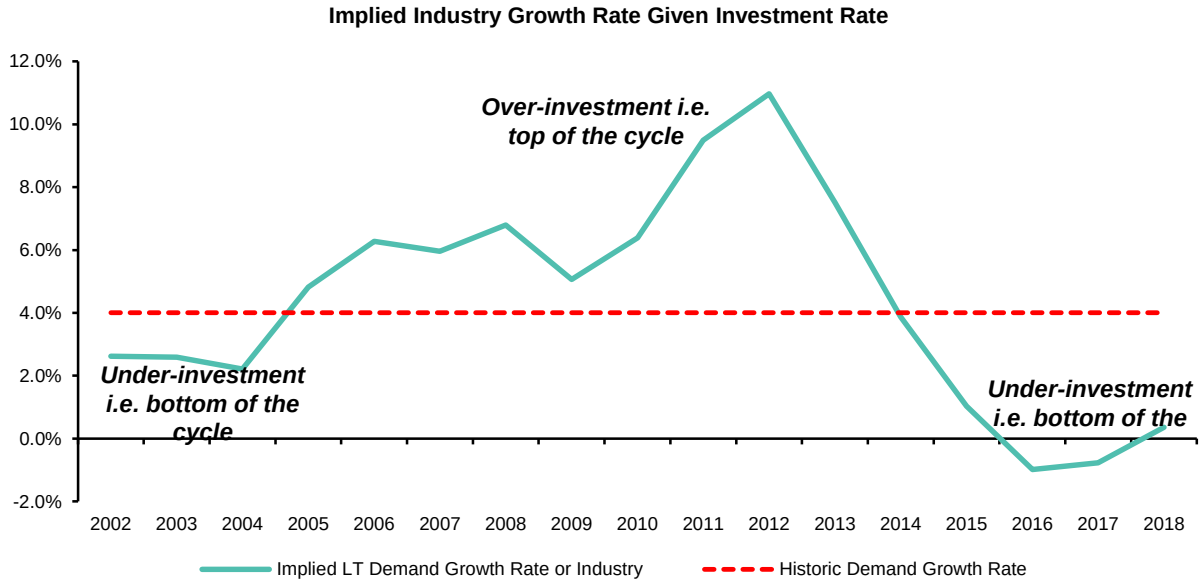


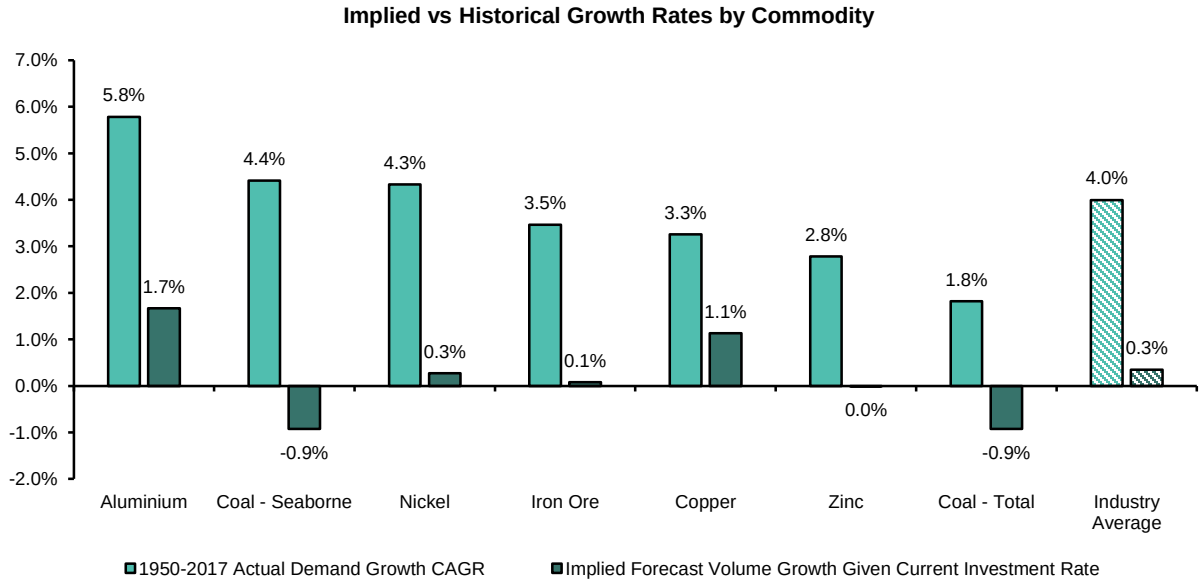
Source: Brook Hunt, Wood Mackenzie and Bernstein analysis

Cyclical considerations...from feast to famine.



Understanding the implications of underinvestment.





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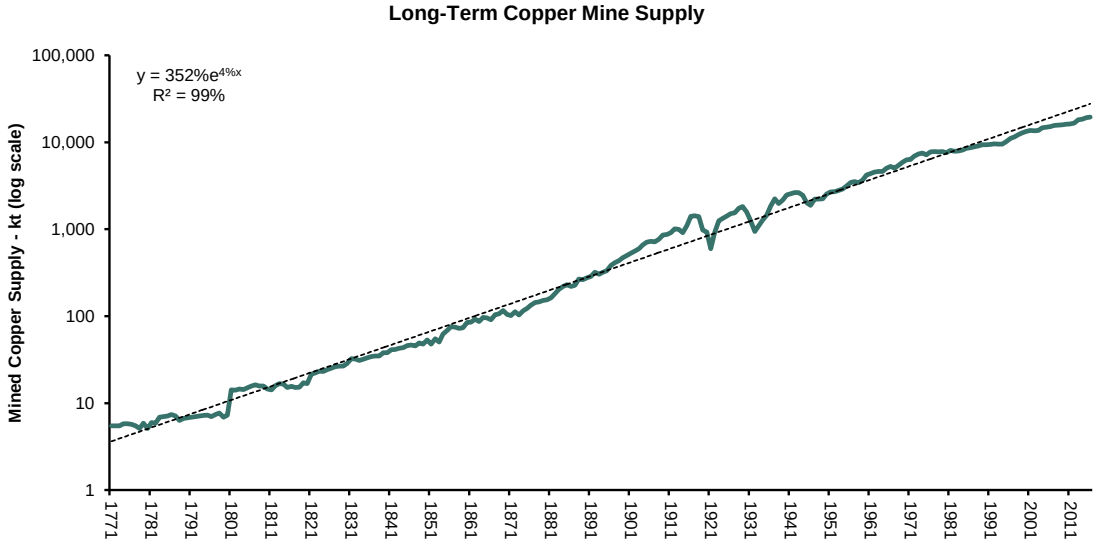
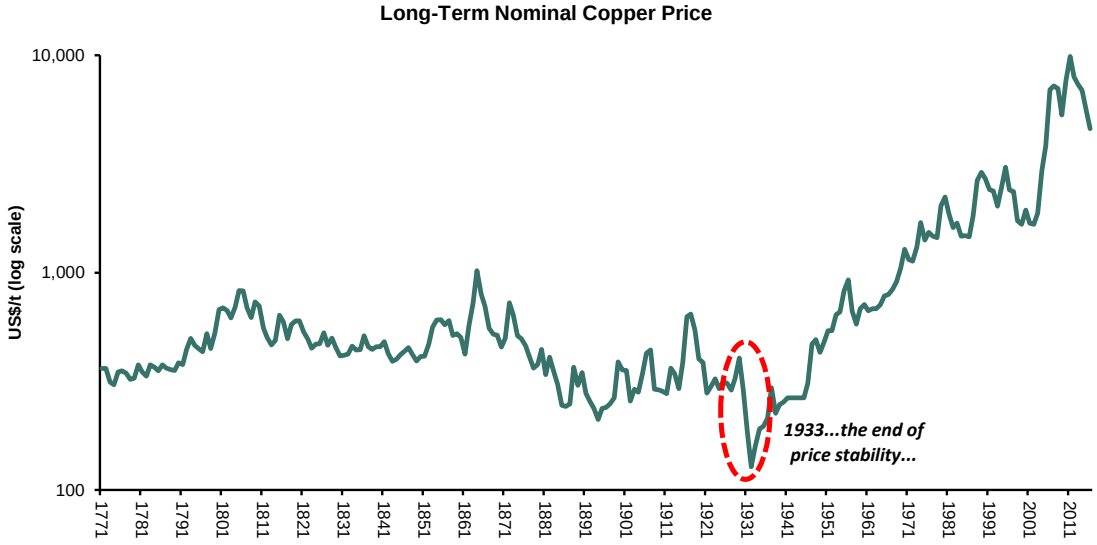
The Long Term Trends…A Few Historical "Facts"

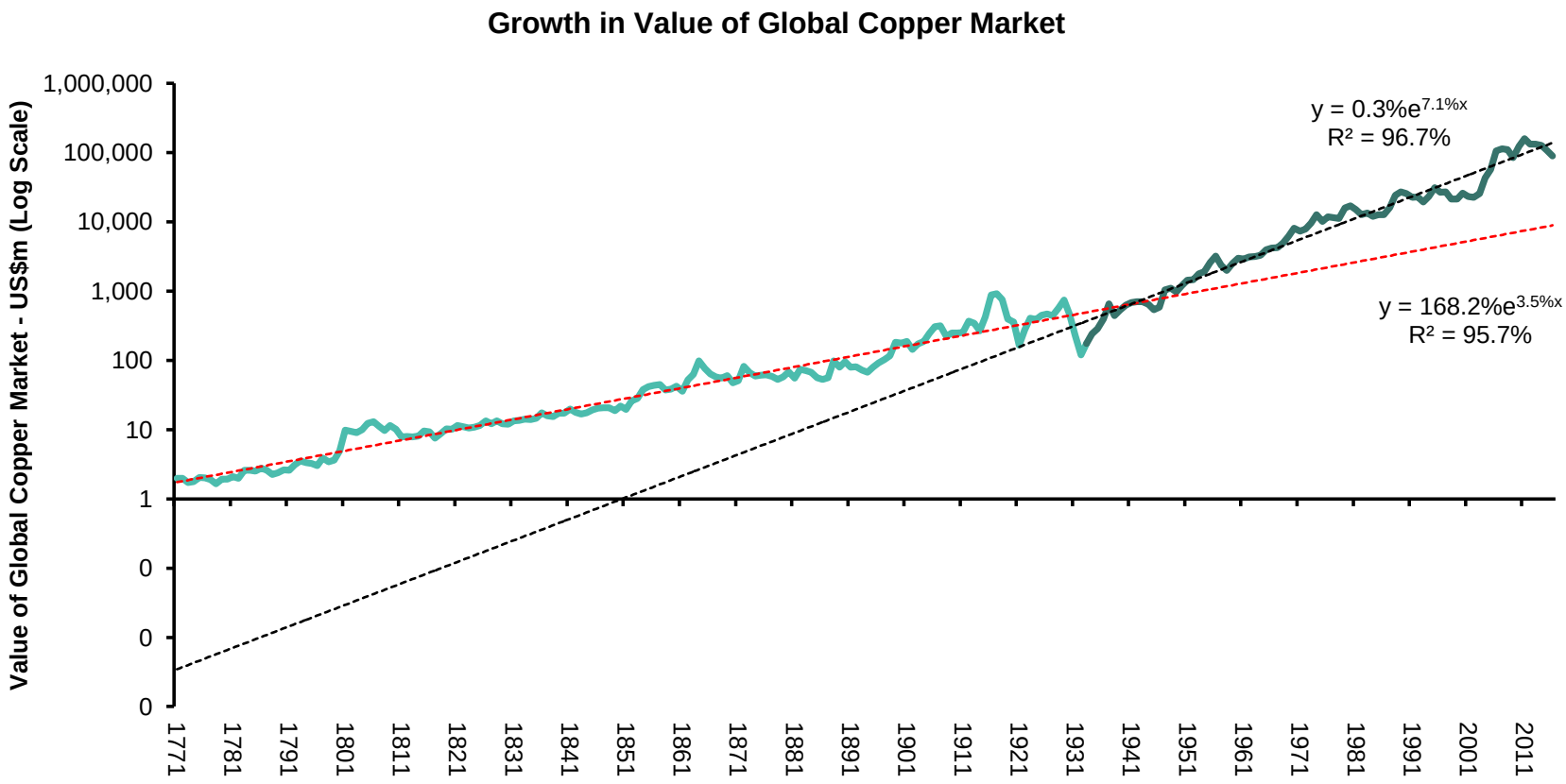




- So much in the industry is a matter of interpretation, everyone has an opinion on what data is important and on what that data means.
- We present what we believe are the two most basic economic "facts" in the industry.
- In the first place, demand for commodities (in a trend sense) grows over time. The development of the global economy is, we believe, synonymous with the growth in output of raw materials. Raw materials represent the beginning of the productive process that culminates in the provision of consumer services and goods. No growth in raw material output implies no growth in these goods and services.
- In the second place – nominal commodity prices rise over time (at least they have since we abandoned the gold standard).
- "Real" prices are of course important but theses real prices tell us as much about the choice of deflator as the price series we look to analyze.

Source: Wood Mackenzie, Schmitz, and Bernstein estimates and analysis

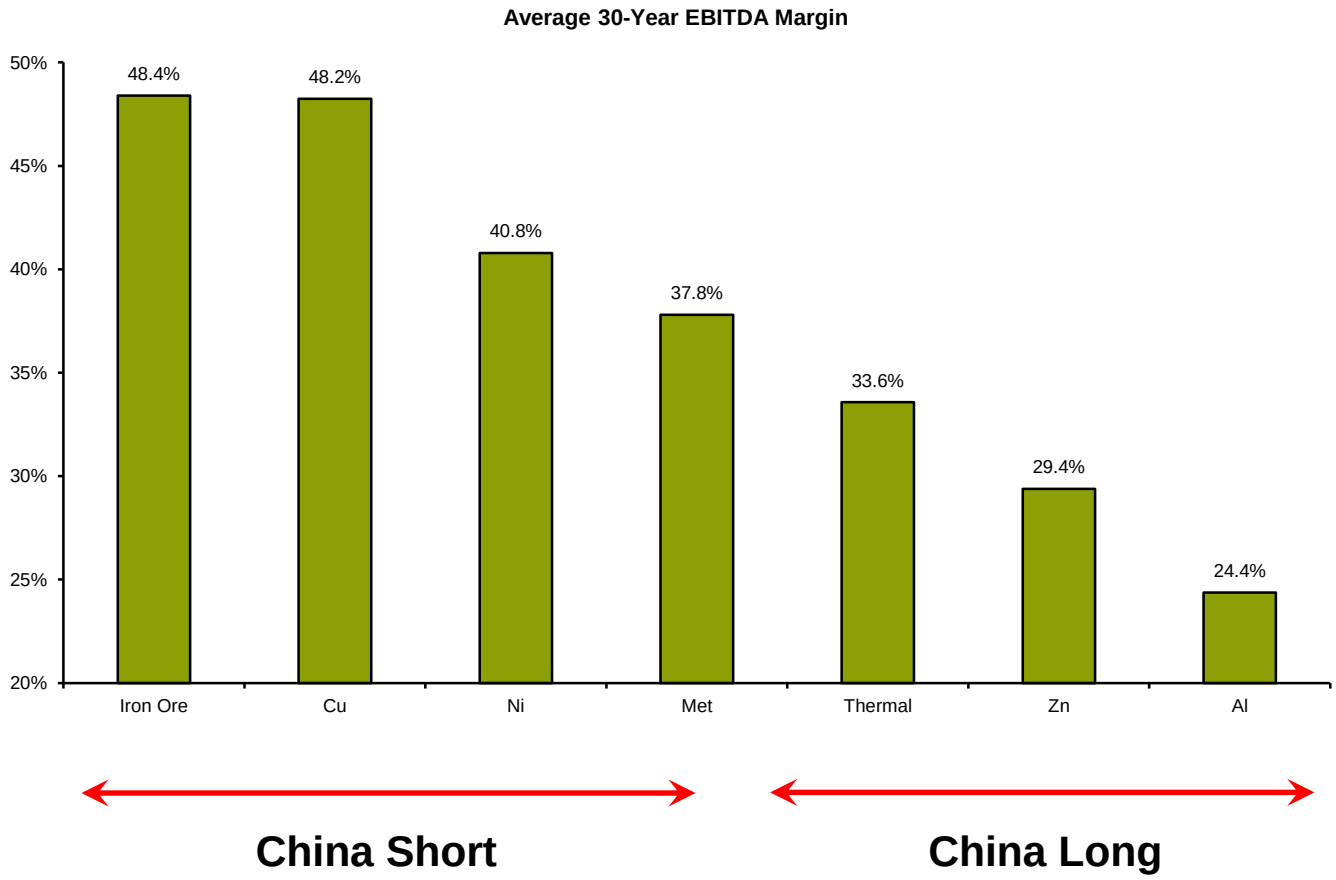
Price and Volume…The Value of The Commodity Markets



Source: Wood Mackenzie, Schmitz, and Bernstein estimates and analysis

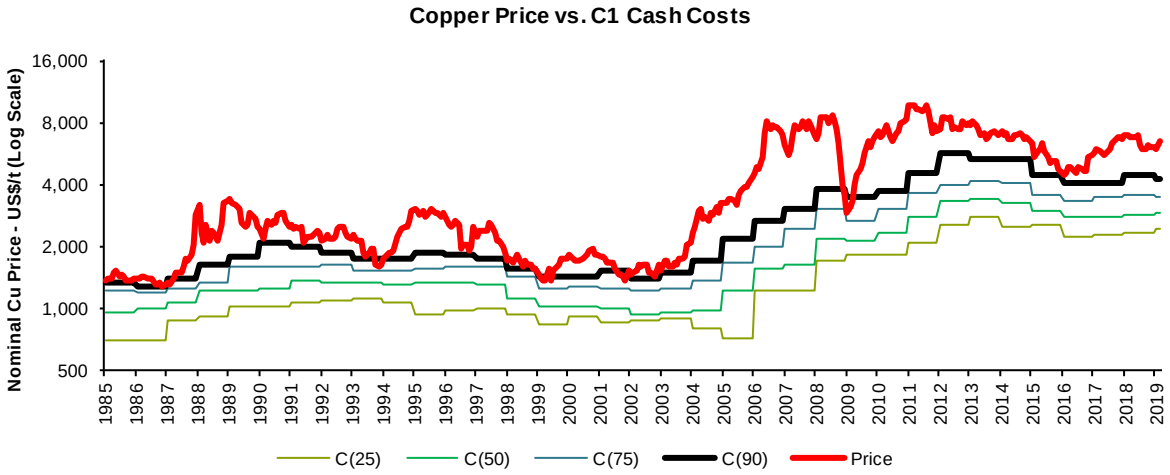
30 Year History of Commodity Performance

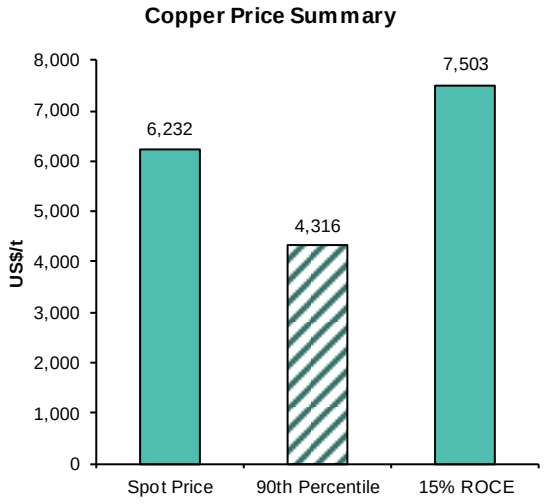
- The rank ordering of commodities is clear and reflects the underlying geological and capital barriers to entry.
- High margins are required for geologically complex commodities, low margins where this complexity is absent.
- The rank ordering is, essentially, a measure of the commodities that China is short versus long.

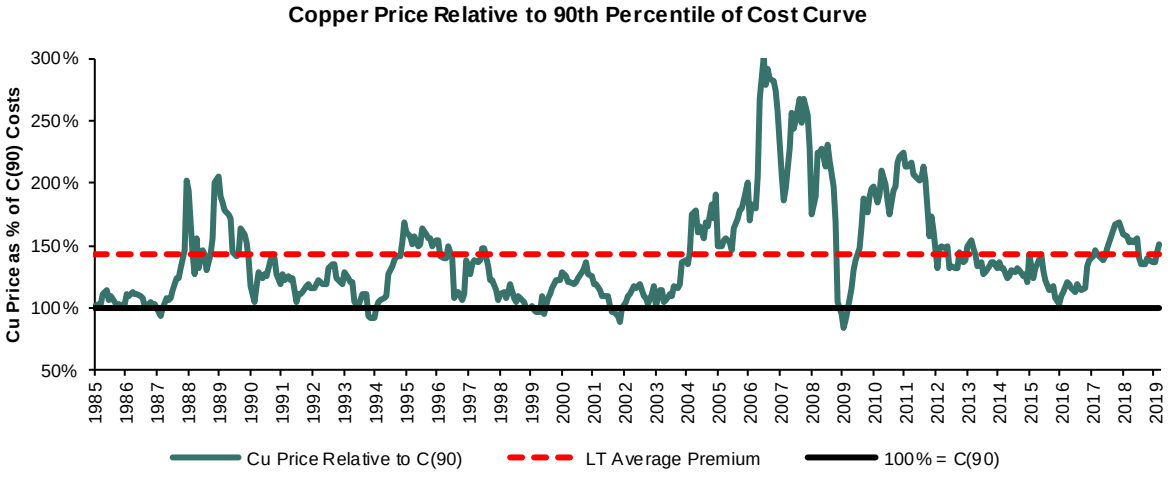


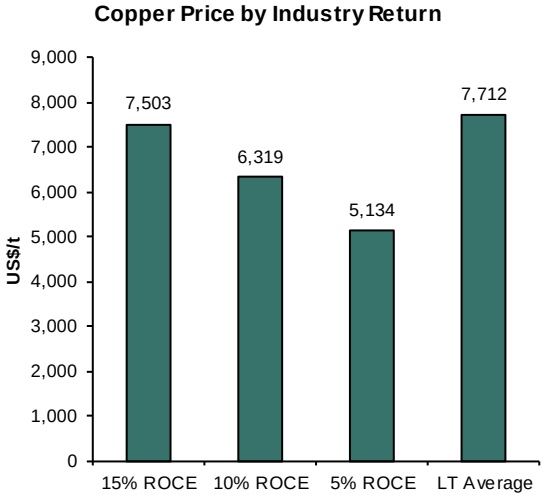
Source: Bloomberg, Wood Mackenzie, AME, CRU, Bernstein Analysis & Estimates

Copper has very rarely traded at marginal cash costs, it has averaged 42% above marginal cash costs on a month by month basis since 1985



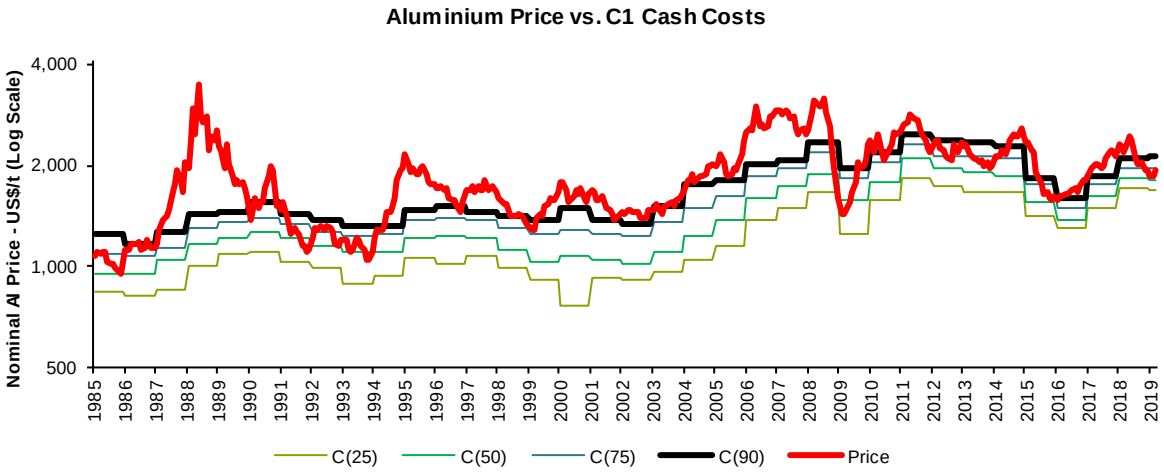


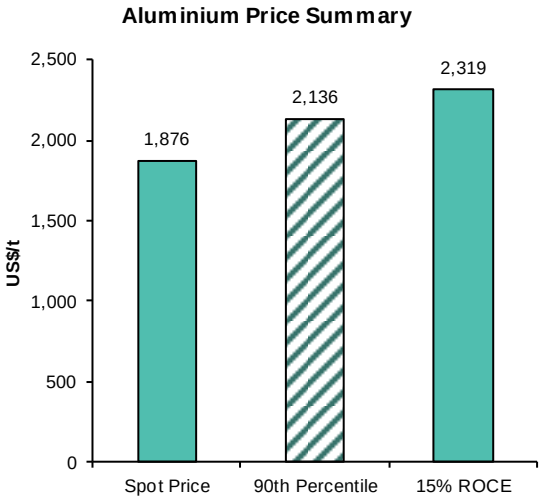


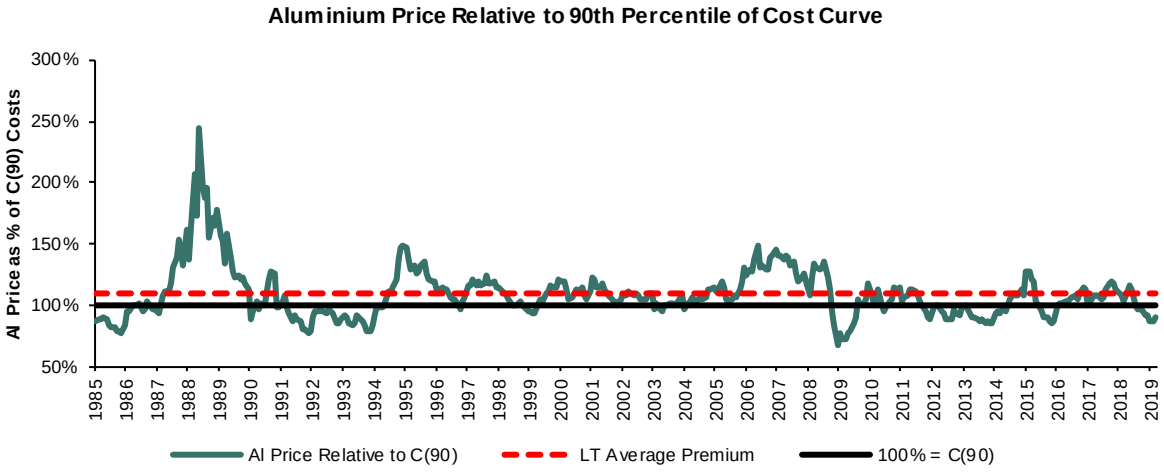


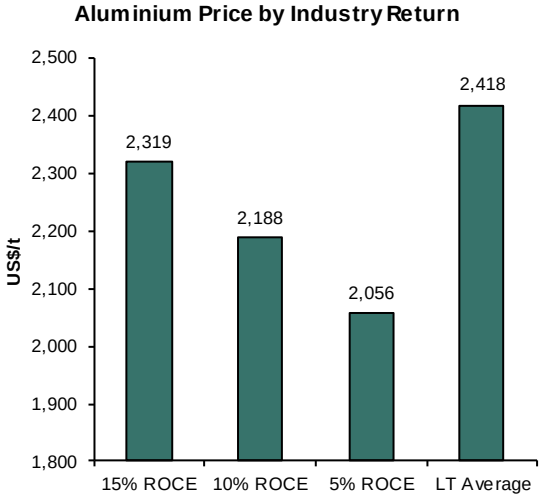
Source: Bloomberg, CRU, AME, Bernstein Analysis & Estimates

Aluminium is the commodity with the lowest premium above marginal costs historically at 9%



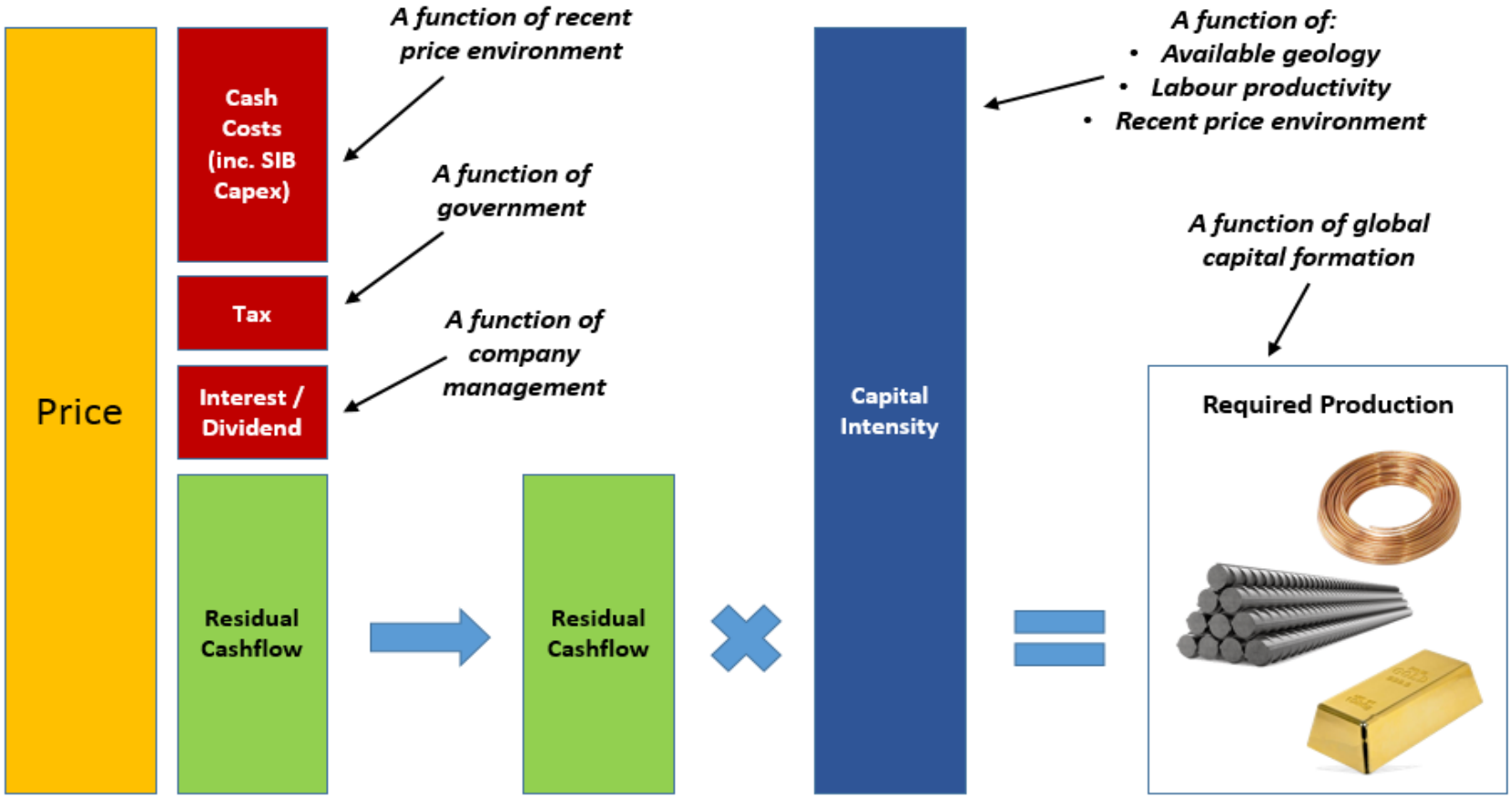






Source: Bloomberg, CRU, AME, Bernstein Analysis & Estimates

Price formation…not *supply=demand*, but *supply growth = demand growth*.

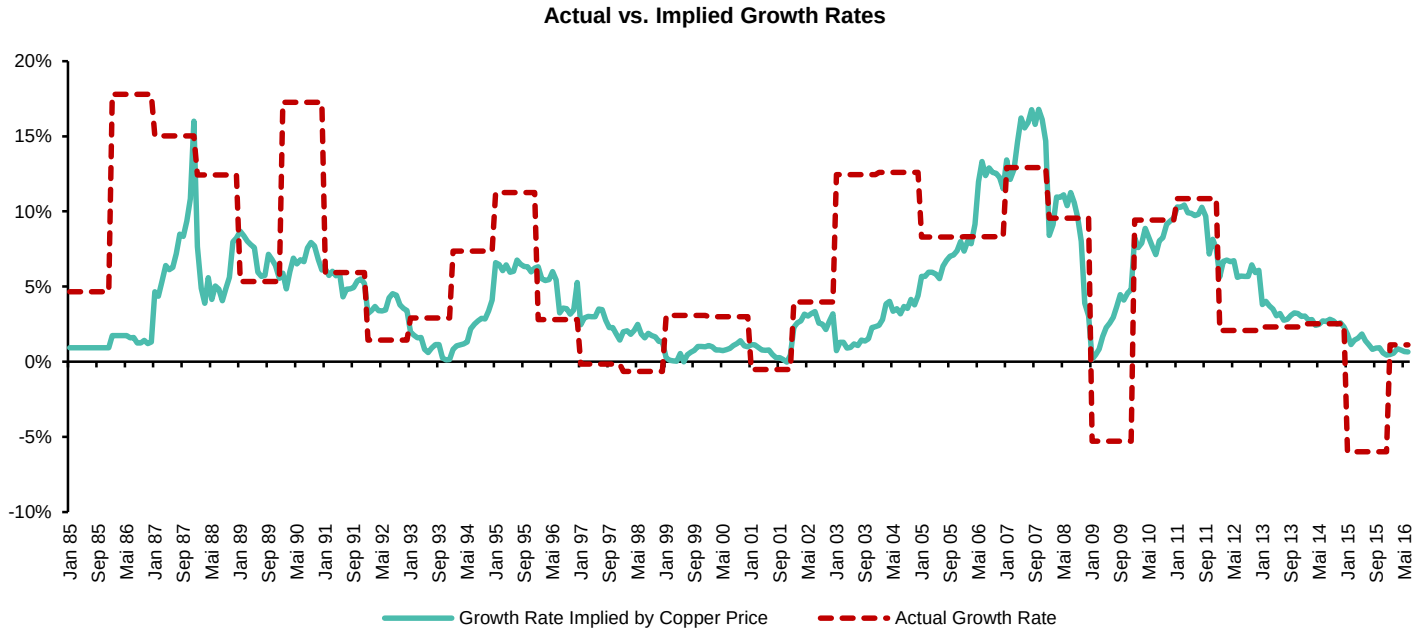


Source: Bernstein, Wikimedia Commons

…price volatility and demand growth expectations.

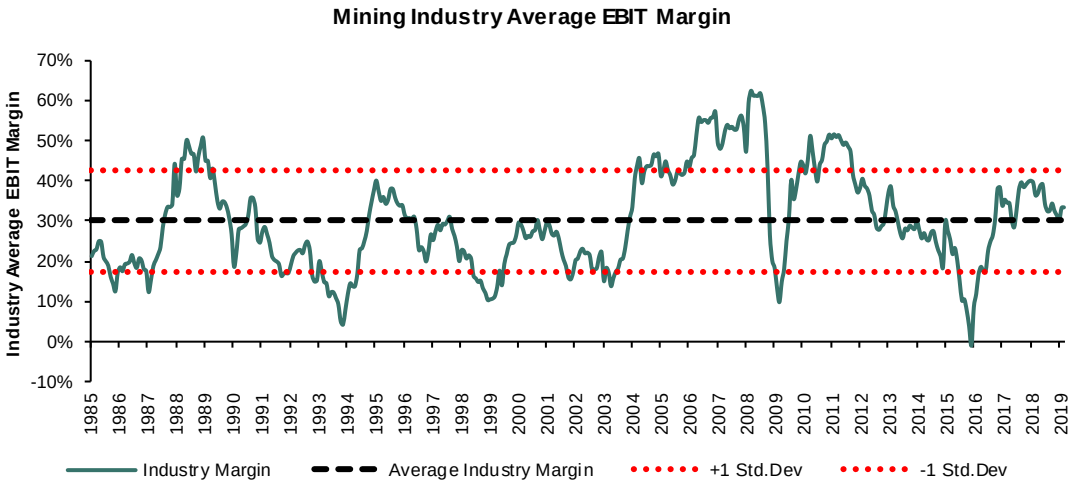
+ Inverting the neo-classical growth model allows the derivation of the following equation to give the equilibrium price level. This is given credence by the close relationship between implied and actual growth rates in reality

Equilibrium Price Level	$P = C + K \cdot \left[\frac{G}{(1-T)\cdot(1-D)} + \frac{1}{L}\right]$
Equilibrium ROCE	$ROCE = \frac{G}{(1-T)\cdot(1-D)}$

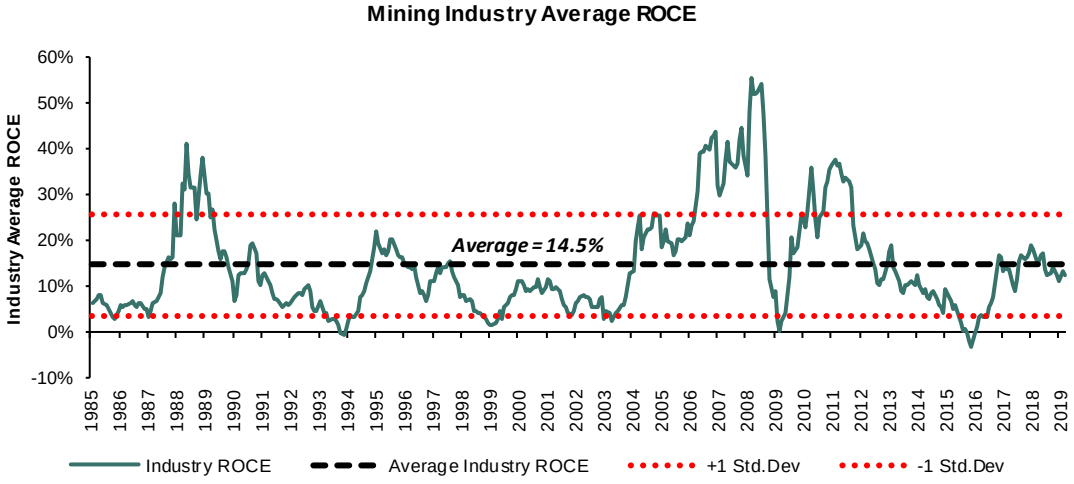


Source: IMF, World Bank, Wood Mackenzie, ICSG, corporate reports, and Bernstein analysis

Mean reversion in mining…margins and returns.



+ We reached the nadir of EBIT margin generation in December 2015, when margins reached a record low of -1.3%. Subsequently, we saw some cost taken out across the industry, as we had expected we would, and then a rebound in commodity prices which saw EBIT margins jump back dramatically



+ Since the beginning of 1985, the mining industry has generated a nominal return on capital of 14.5%, the distribution of those returns is largely clustered around the 6-12% range, but with a long tail of much higher returns from various points in time. As such, the median nominal ROCE over this period is much lower than the mean, at 11.2%

Source: Wood Mackenzie, AME, CRU, Bloomberg L.P., and Bernstein estimates and analysis.

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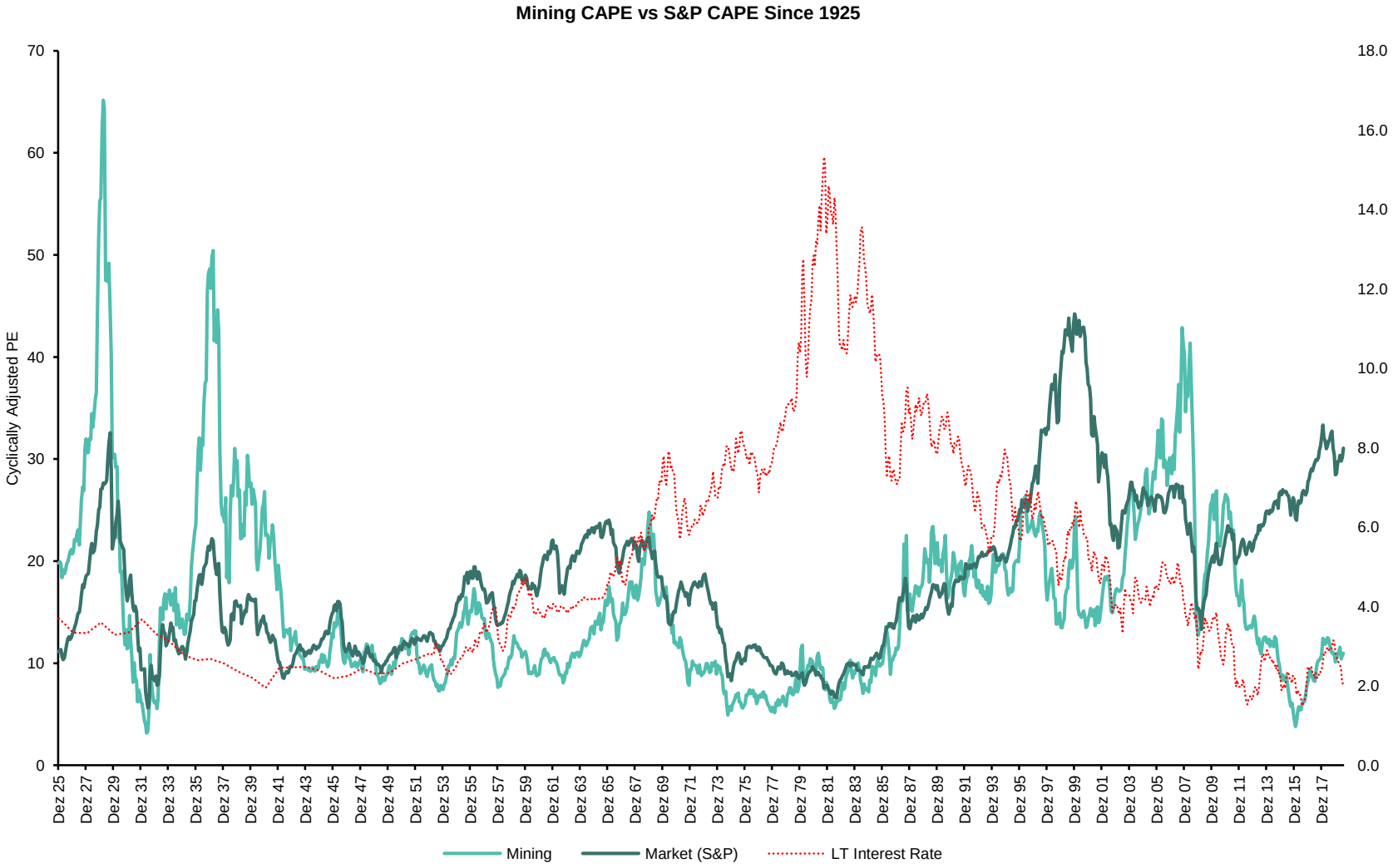
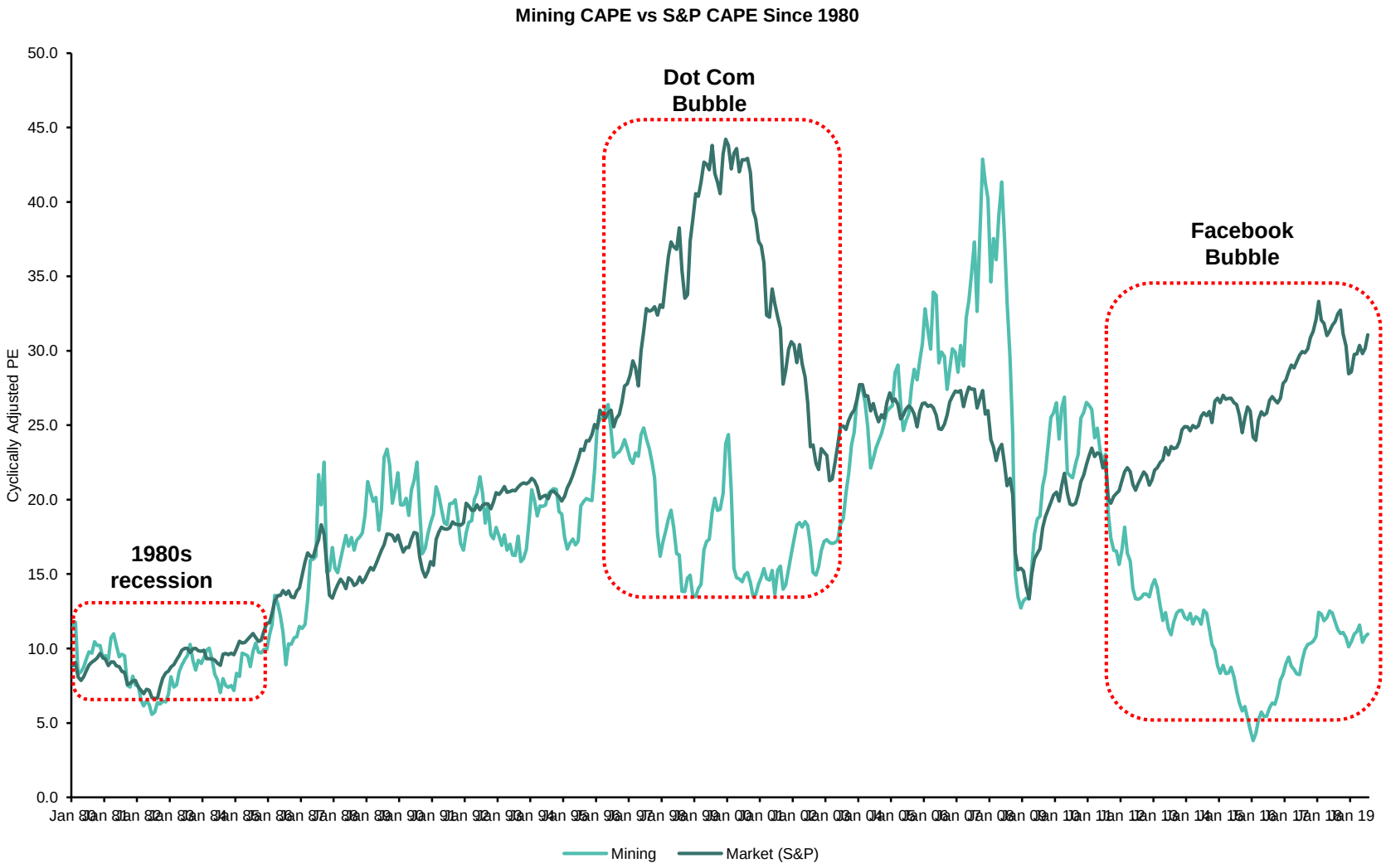
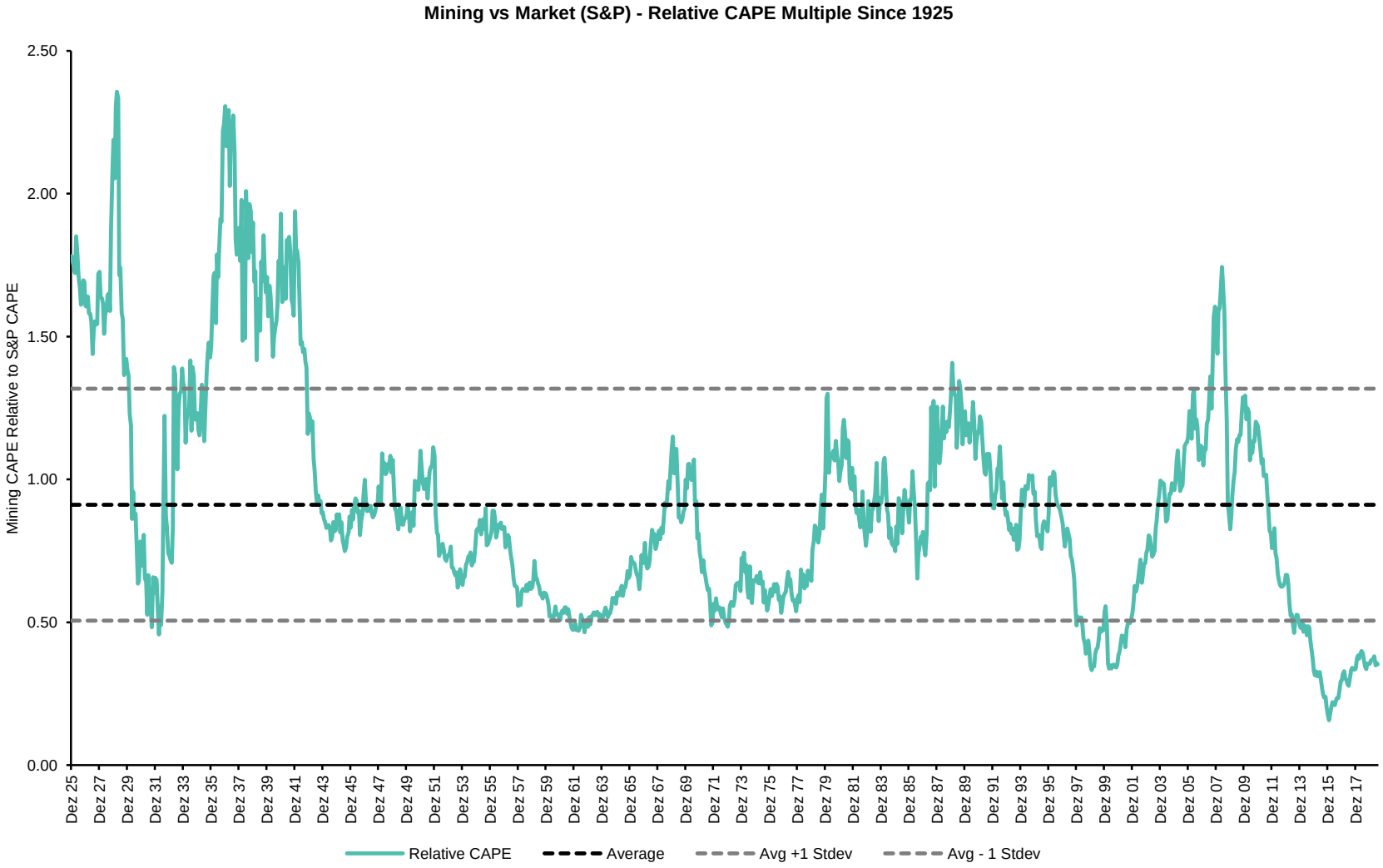
Mining versus the market...the 100 year perspective



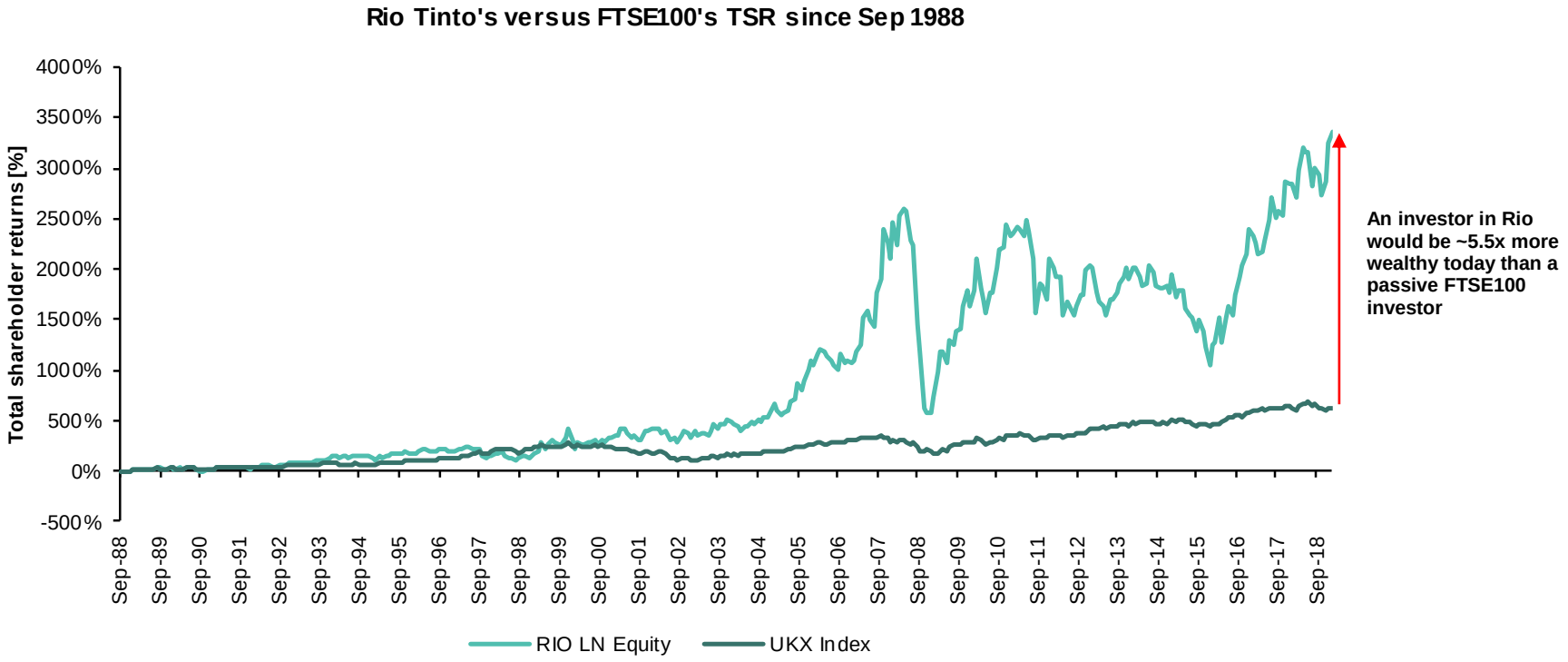
A repeat of the Dot Com bubble?



Valuations disconnect (on Schiller PE) has never been wider...

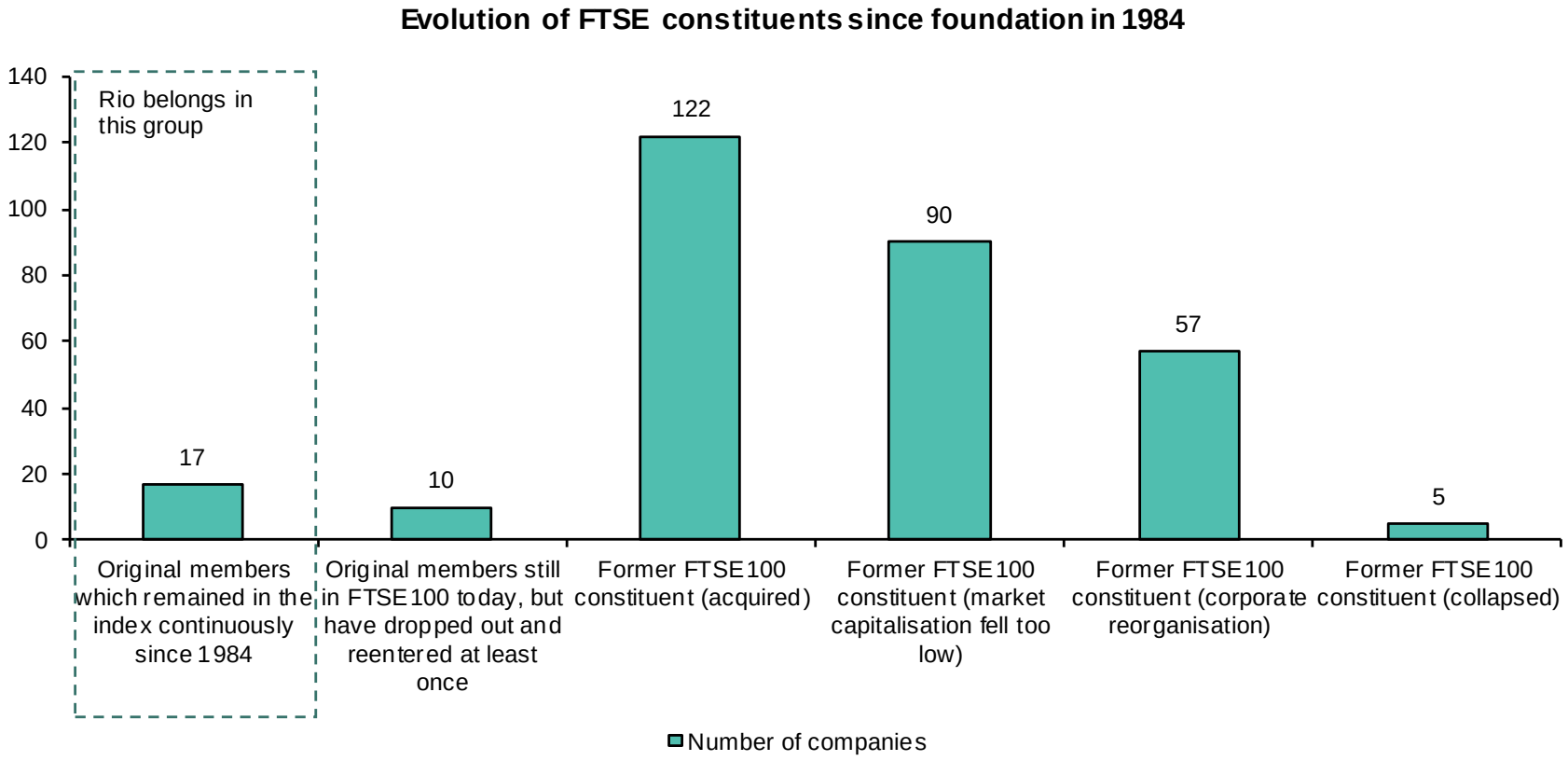


Rio Tinto's total return since September 1988 is ~5.5x the return of FTSE100



Source: Bloomberg, Bernstein Analysis & Estimates

Rio is one of 17 companies which have remained in the FTSE100 index continuously since its foundation



Source: Bloomberg, FTSE, Bernstein Analysis & Estimates

Within this group of “FTSE100 survivors”, Rio has a top-quartile total shareholder return (TSR)…

Company name	Ticker	Sector	TSR since Sep 1988	Annualised TSR since Sep 1988	P/E	EV/ EBITDA	P/B
Unilever	ULVR LN Equity	Consumer, Non-cyclical	3,828%	12.8%	18.4	14.0	11.1
Reckitt Benckiser Group	RB/ LN Equity	Consumer, Non-cyclical	3,689%	12.7%	16.9	13.1	2.9
Legal & General Group	LGEN LN Equity	Financial	3,506%	12.5%	9.5	-	2.1
Rio Tinto	RIO LN Equity	Basic Materials	3,358%	12.3%	10.3	5.7	2.2
Prudential	PRU LN Equity	Financial	2,939%	11.9%	10.9	-	2.6
Smith & Nephew	SN/ LN Equity	Consumer, Non-cyclical	2,087%	10.7%	18.7	11.9	3.5
Reed Elsevier	REL LN Equity	Consumer, Non-cyclical	1,783%	10.1%	18.2	13.8	14.0
BP	BP/ LN Equity	Energy	1,462%	9.5%	13.0	4.9	1.4
Tesco	TSCO LN Equity	Consumer, Non-cyclical	1,046%	8.3%	16.4	7.8	1.6
FTSE100	**UKX Index**	**-**	**629%**	**6.7%**	**12.7**	**7.7**	**1.7**
Barclays	BARC LN Equity	Financial	597%	6.6%	8.0	-	0.5
Pearson	PSON LN Equity	Communications	593%	6.6%	14.8	8.9	1.4
Royal Dutch Shell	RDSB LN Equity	Energy	555%	6.4%	10.7	6.0	1.3
Land Securities Group	LAND LN Equity	Financial	455%	5.8%	15.3	19.5	0.7
Marks & Spencer Group	MKS LN Equity	Consumer, Cyclical	399%	5.4%	11.3	5.4	1.6
Lloyds Banking Group	LLOY LN Equity	Financial	384%	5.3%	8.8	-	1.0
J Sainsbury	SBRY LN Equity	Consumer, Non-cyclical	259%	4.3%	10.6	3.8	0.7
RBS Group	RBS LN Equity	Financial	53%	1.4%	9.3	-	0.7

Source: Bloomberg, Bernstein Analysis & Estimates

Disclosure Appendix

Ticker Table

Ticker	Rating		May 13, 2019 Closing Price	Target Price	Rel. Perf.		EPS Adjusted 2017A	EPS Adjusted 2018E	EPS Adjusted 2019E	EV/EBITDA 2017A	EV/EBITDA 2018E	EV/EBITDA 2019E
AAL.LN	O	GBp	1,892.80	2,650.00	6.5%	USD	2.62	3.06	3.20	4.37	4.06	4.02
ANTO.LN	M	GBp	835.60	1,100.00	(16.3)%	USD	0.56	0.91	1.03	5.95	4.82	4.38
BHP	M	USD	51.87	46.41	1.7%	USD	4.06	5.99	7.51	6.84	5.99	5.53
BHP.AU	M	AUD	36.93	36.70	25.8%	USD	2.03	3.00	3.75	6.81	5.97	5.51
BBL	M	USD	46.00	52.09	(0.6)%	USD	6.19	9.12	11.43	7.18	6.29	5.80
BHP.LN	M	GBp	1,743.00	1,800.00	11.6%	USD	1.23	1.81	2.38	6.81	5.97	5.51
FM.CN	O	CAD	12.45	26.00	(45.9)%	USD	(0.16)	0.74	1.05	11.90	7.74	5.77
GLEN.LN	O	GBp	280.85	500.00	(19.5)%	USD	0.39	0.46	0.65	5.59	4.93	4.07
RIO.LN	O	GBp	4,412.00	5,000.00	14.3%	USD	4.85	5.44	5.95	5.28	5.44	5.17
RIO	O	USD	58.87	71.62	1.5%	USD	4.85	5.44	5.95	5.36	5.52	5.25
S32.AU	M	AUD	3.34	3.45	(5.1)%	AUD	0.31	0.37	0.44			
S32.LN	M	GBp	177.00	190.00	(13.2)%	USD	0.22	0.26	0.31	4.58	4.39	3.93
S32.SJ	M	ZAr	3,249.00	3,143.39	(3.5)%	ZAR	2.83	3.33	3.98			
VALE3.BZ	O	BRL	49.46	70.00	5.2%	USD	1.23	1.35	2.05	5.23	4.84	4.55
VALE	O	USD	12.47	18.90	(20.3)%	USD	1.23	1.35	2.05	5.22	4.83	4.55
IVN.CN	O	CAD	3.25	16.00	(4.4)%	USD	0.22	(0.07)	(0.04)	9.18	(29.72)	22.35
MSDLE15			1,554.07				101.45	107.57	112.57	15.32	14.45	13.80
MXAPJ			518.47				36.60	38.29	43.05	14.17	13.54	12.04
MXEF			1,033.44				80.25	85.40	96.87	12.88	12.10	10.67
SPX			2,881.40				128.74	159.60	164.91	22.38	18.05	17.47

O - Outperform, M - Market-Perform, U - Underperform, N – Not Rated

AAL.LN,ANTO.LN base year is 2018;. AAL.LN,ANTO.LN,BHP,BBL,BHP.LN,FM.CN,GLEN.LN,RIO.LN,RIO,S32.LN,S32.SJ,VALE3.BZ,VALE,IVN.CN close date is 05/10/2019;.

Disclosure Appendix - Valuation Methodology

European Metals & Mining
Our price targets are based on a sum of the parts and DCF analysis. We forecast FCF per business unit for each company in our coverage, using our own commodity price forecasts, and aggregate the numbers into a DCF.

Disclosure Appendix - Risks

European Metals & Mining
The four most significant risks facing the major mining houses are lack of capital discipline, operating cost inflation, a sustained downturn in the Chinese economy and resource nationalism.
+Capital discipline. Capital discipline is perhaps the most important mechanism by which the mining industry can create value. We have seen lapses in capital discipline before, and a return of such periods would lend downward pressure to prices.
+Operating cost inflation. Following 10 years of double-digit US dollar-denominated cost inflation in the industry, unit costs have come down in recent years as commodity prices have fallen. We expect to see a return of cost inflation, but should this be stronger than we expect, then it has the capacity to erode value.
+Chinese economic risks. China is important in commodities as both the major source of demand growth and as the location of the marginal units of supply. The market has become extremely sensitive to sentiment regarding the Chinese economy, with the level of leverage of particular concern.
+Resource nationalism. Finally, we note with concern the trend toward global fragmentation and the ever greater desire to extract value from the mining sector. We believe that this is ultimately a self-defeating strategy by host governments, but it is one with an impressively long pedigree. Persistent macroeconomic headwinds will make this an ever more attractive option.

Anglo American PLC
For Anglo American in particular, inability to improve the efficiency of its platinum operations and continued margin pressure arising from South African labour inflation poses downside risk, as does the potential for increased union militancy in South Africa (and again in platinum in particular). A continued deterioration in labor unrest along with the attendant physical hazards, delays and expenses could weigh on results. Further delays at the Minas Rio iron ore project in Brazil would also be a significant negative catalyst, whilst cost overruns, execution issues and delays at Quellaveco would also impact value.
Antofagasta PLC
We continue to like copper, and of course as a copper pure play, Antofagasta is poised to benefit from the upside we see in the commodity. However, the main incremental risks for Anto are probably structural, long-term Chilean specific ones, i.e. water, labour and investment opportunities. Water scarcity is a huge problem in many mining jurisdictions but particularly Chile, and this is of course why the Los Pelambres expansion needs the desalination plant which of course adds to the capital intensity of the project. In terms of labour, wage rates in Chile have been rising for some time now, and we have seen a lot of manifestations of industrial unrest in the very recent past with the strikes at other major mines in the country. Finally, in terms of investment opportunities (and of course both water and labour feed into this) we are seeing Chile as a less and less attractive destination for investment itself, and increasingly see the “new world” sources of production (the DRC, Zambia) as the way forward for the industry, rather than Chile.

BHP Billiton PLC
+In the case of BHP Billiton, company specific risks include continued weakness in the price of natural gas in the US and iron ore. Repeats of the weather induced volume losses in BHP’s metallurgical coal operations as well as continued labour related disruptions in these assets could also prove an impediment to our price target.
First Quantum Minerals Ltd
First Quantum must handle four key risks or challenges:

1) Country risk. Half of First Quantum's current revenue and reserves come from Zambia, a country that has experienced severe political instability in the past years.

Disclosure Appendix - Risks

2) Complexity of portfolio. First Quantum operates in 12 countries! The company's assets are located in Zambia, Spain, Mauritania, Australia, Finland, Turkey, Panama, Peru and Argentina. The company is registered in Vancouver, Canada, and has representative offices in Perth (Australia), London (UK), Johannesburg (South Africa) and Toronto (Canada). This involves complexity in the portfolio, significant FX, political and fiscal risks.

3) High leverage.

4) Risks associated with the ramp-up at Cobre Panama, including the uncertainty posed by the Supreme Court's ruling on the invocation of Law 9. Though the company has received vocal support from the Government of Panama and continues to develop the mine, the current lack of clarity surrounding the issue is clearly a headwind for the stock.

Glencore PLC

+In the case of the mining division, company specific risks include continued weakness in commodity prices. Operationally, the biggest challenge is the transition required to replace some older assets towards the end of their LOM with newer assets (e.g. in copper Tintaya and Antappacay).

+The trading business requires high levels of working capital and remains vulnerable to large swings in cash-flow generation as a result. We note as a result of its operations in frontier jurisdictions, as well as the unknown nature of embedded risk and persistence of edge in the marketing book, headline risk remains a significant concern.

Rio Tinto PLC

+In the case of Rio Tinto, company specific risks include any sustained down turn in the price of iron ore will negatively impact Rio as the company is the second most exposed of our coverage group to iron ore (after Vale). Any relaxation of capital discipline particularly around the Simandou project in Guinea would also be, in our view, a negative catalyst. Execution delays in the commissioning of the Oyu Tolgoi copper project in Mongolia or significant revenue grabs from the Mongolians could also be a risk.

South32 Ltd

In the case of South32, company specific risks include continued weakness in the price of manganese and aluminium. In addition, if the company seeks to acquire growth, given the lack of organic growth in its portfolio, then any premium paid for either copper or iron ore assets would represent a pure transfer of value away from S32 shareholders. On the upside, there is still a possibility that a bidder comes in to take out South32, particularly as the company has sold-off significantly since listing.

Vale SA

+In the case of Vale, company specific risks include any sustained down-turn in the price of iron ore as the company derives nearly the entirety of its value from exposure to iron ore. The continuation of disruptions to the output of nickel and attendant cost pressures are also a risk. The commissioning of Goro (VNC) is an issue that needs to be addressed, as is the performance at Onca Puma.

Ivanhoe Mines Ltd

For Ivanhoe specifically, the major risk remains country risk, given that the three assets in the company's portfolio are located in Africa and that 90% of enterprise value comes from Congolese assets.

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Ticker	Rating Changes	
AAL.LN	O (IC) 09/05/12	
ANTO.LN	M (RC) 04/17/19	O (RC) 11/26/14
BBL	M (RC) 01/22/18	
BHP	M (RC) 01/22/18	
BHP.AU	M (RC) 01/22/18	
BHP.LN	M (RC) 01/22/18	
FM.CN	O (IC) 06/02/15	
GLEN.LN	O (RC) 02/13/13	
IVN.CN	O (IC) 12/09/16	
RIO	O (IC) 09/05/12	
RIO.LN	O (IC) 09/05/12	
S32.AU	M (RC) 08/20/15	
S32.LN	M (RC) 08/20/15	
S32.SJ	M (RC) 08/20/15	
VALE	O (RC) 01/25/17	
VALE3.BZ	O (RC) 01/25/17	

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