

# THE BURGUNDY

Issue 18

March, 2017



## Productivity in Mining

An abundance of funding, labor, end markets but a dearth of productivity

*Since mining companies do not control commodity prices, they forecast demand to drive decisions on production and capital investment. As no communication occurs between the various players globally, mining companies fall prey to the strongest form of game theory; they all do the same things at the same time while hoping for differentiated results. Further impeding wealth creation is the industry's inability to reverse supplier bargaining power through productivity. Whatever success in production growth is met with even greater operating and capital cost growth. In the decade from 2004 to 2013, productivity fell 28%. Since 1892, the industry recorded three leaps of human ingenuity in productivity - manual, mechanised, and in-situ remote production. Automated production, achieved in late comer industries such as electrical appliance and automobile manufacturing, is a pipe dream for the mining industry. Three quarters of initiatives to structurally shift mining costs lower fail. Without this protective layer, mining companies remain overly dependent on commodity prices for profitability. Forecasting errors on demand combined with the detrimental influence of game theory on supply, lead to perpetual cycles of capital investment and impairment thereof. Periodically, investors may successfully speculate on listed resource equities but not consistently enough to build wealth.*

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### **An offer you can refuse...**

**Seller:** Prices are set by the market, not you. However, you may cut your price to below the market price should you want to move inventory faster than your peers. Your fixed costs, however, increase annually without fail – some at the rate of inflation but most, owing to strong bargaining power, rise at far more than inflation. Not least of these are wages because of unionisation. Your capital costs also rise annually at a rate far more than inflation reflecting both the bargaining power of your concentrated supplier base and your reluctance to switch away from them. The quality of your raw materials also degrades over time, making it ever costlier to produce the end product. This pretty much inhibits the one lever that you fully control: ramping up volume to lower unit costs.

Would you like to buy this business?

**Buyer:** How much are you selling it for?

**Seller:** Oh, one more thing. Unlike automobile manufacturing, there is a technological limit which restricts you from automating a material part of your cost base. In other words, you will never be able to reverse the bargaining power suppliers have against you no matter how much you transform the business.

Do you still want this business?

**Buyer:** How much cash typically sits in the business?

**Seller:** It depends a where we are in the cycle. The business typically has far more debt than cash though.

**Buyer:** So, what do I get to own if I bought it?

**Seller:** Besides equipment, you get preferential access to the raw materials under Government license. Naturally, you should expect the conditions attached to this license to change from time to time. Such changes can happen at any time and may even require you to change your ownership structure.

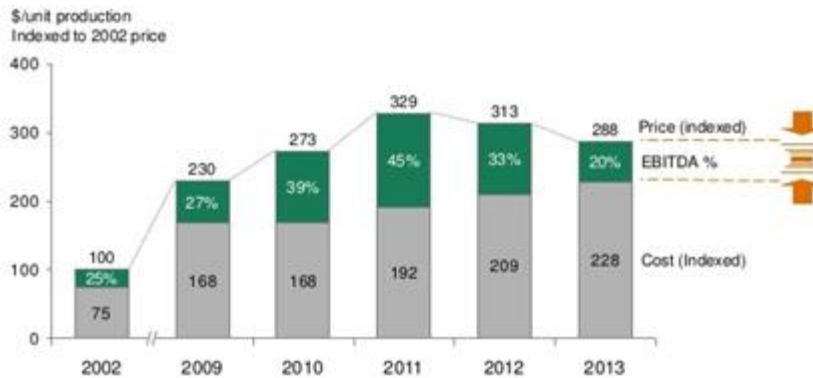
**Buyer:** Umm. I think I'll pass.

**Seller:** Well, please make me an offer.

### **But your investment manager can't**

Business people are far more circumspect about buying a mining business than portfolio managers are of buying shares of listed resource equities. The influence of commodity prices on profitability far outweighs that of any factor within the control of management. Chief among these factors would be the productivity of operating and capital costs. There is simply no opting out of incurring costs, nor is perennial cost cutting and a boycott of sustainable capital expenditure plan an option (Figure 1)

**Figure 1: Commodity Prices Go on a Random Walk While Operating Costs Rise**



Source: BCG

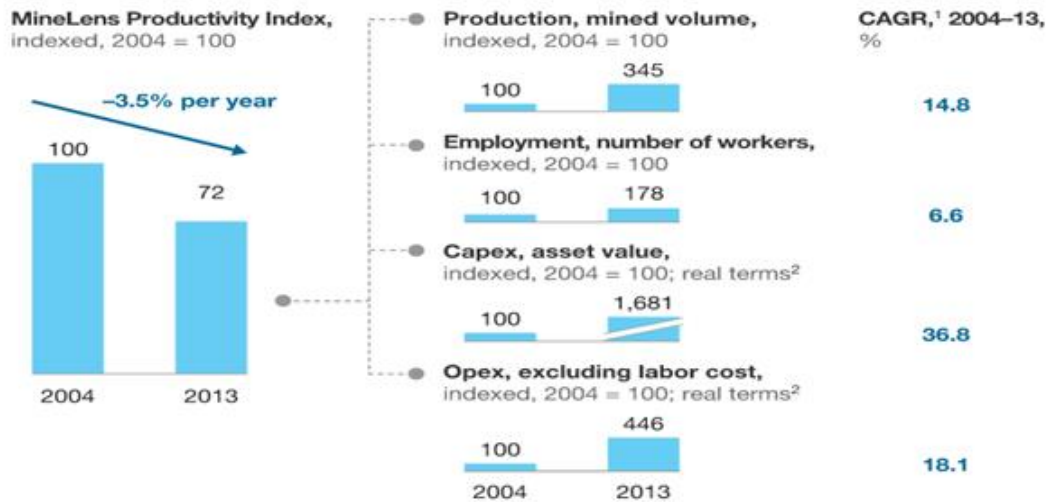
That the profits of an industry rise and fall with rising or falling commodity prices, shows an inability by company management to increase costs at a slower pace than revenues and sustain that improvement. In other words, human ingenuity in the industry fails to figure out how to increase volumes without incurring materially more costs. Ultimately, management desperately require rising commodity prices to bail them out of incessant cost pressures. This is an existential problem because the entire purpose of going into business, let alone running one, is to arbitrage factors of production for economic profits.

In fact, we can even go on to boldly state that despite centuries of mining experience, man's track record at mining commodities productively has betrayed the progress he's made in other fields of civilization. You only have to look at how productivity fell by 28% between 2004 and 2013, a period in which the world experienced a virulent upcycle in commodity prices (Figure 2).

In that period, the global mining industry increased production growth at a compound rate 14.8%, while real employment growth, capital expenditure, and operating expenditure (excluding labour costs) grew at a higher compound rate of 6.6%, 36.8%, and 18.1% respectively. Volume growth brought along with it even higher operating and capital cost inflation. That is lack of productivity in action.

Commodity prices, as they rise from time to time, mask this woeful track record in productivity. Nowhere is this deficit in productivity more visible, and detrimental to profitability, than when commodity prices decline, as they often do, for extended periods!

Figure 2: Commodity Volume Growth and Productivity Loss: 2004 - 2013



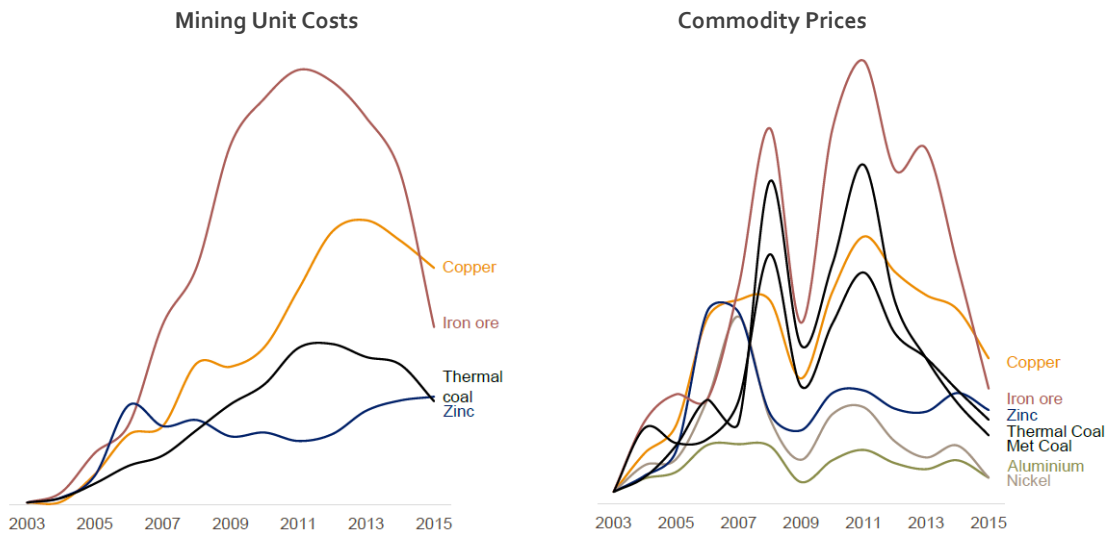
<sup>1</sup>Compound annual growth rate.

<sup>2</sup>Capital expenditures and operating expenditures adjusted for mine cost inflation.

Source: McKinsey and Company

Even in the rare circumstance that industry unit costs fall (e.g., due to the destruction of supply), mining companies ultimately lose out as commodity prices fall faster than costs! (Figure 3)

Figure 3: Mining unit costs and commodity prices, 2003 - 2015



Source: Glencore BMO Global Mining Conference Presentation, Bernstein, Wood Mackenzie

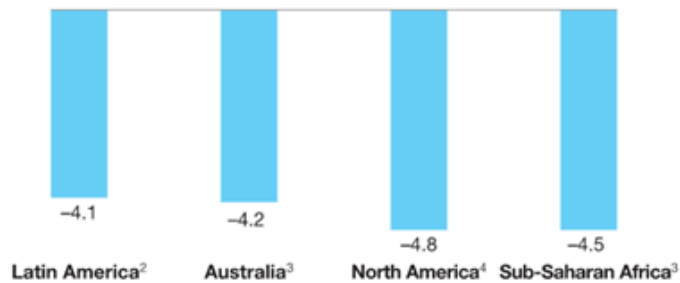
## Geographic and portfolio diversification are myths

There really is nowhere to hide from this phenomenon. Diversification is often touted as the panacea to commodity price volatility. However, mining companies who have operations in various geographies have only succeeded in diversifying away political risk (nationalisation) but have done nothing to address the real problem - loss of productivity. In fact, geographic diversification has exacerbated the productivity. There is not a single geography (country or continent) that has figured out how to sustain productivity gains over time. See Figure 4.

**Figure 4: Geographic Diversification is not a Panacea for Lack of Productivity**

... as well as across most major mining geographies.

**MineLens Productivity Index,<sup>1</sup>**  
compound annual growth rate



<sup>1</sup>Productivity performance is calculated from cost data (for capital expenditures and nonlabor operating costs) using the reported currencies of the mine operators.

<sup>2</sup>Compound annual growth rate (CAGR) is for 2005 to 2012.

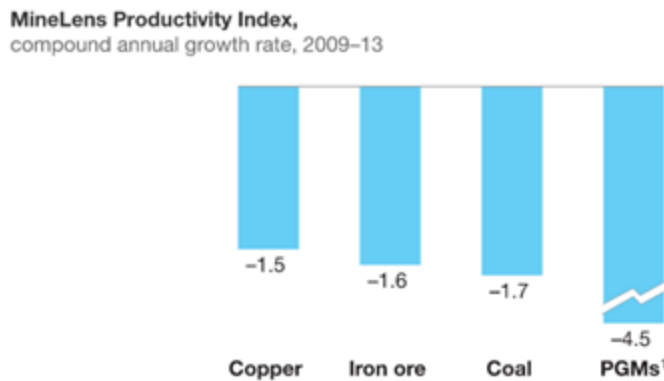
<sup>3</sup>CAGR is for 2004 to 2013.

<sup>4</sup>CAGR is for 2006 to 2013.

McKinsey&Company | Source: Company annual reports; McKinsey analysis

Figure 4 makes a myth out of the truth-like that industry in Australia is the most productive in the world. Latin America just pips Australia to it! Another well-worn perception is that of the benefits of diversification across the metals complex. To be sure, increased productivity is not one of them. See Figure 5.

Figure 5: Nor is Diversification across the Metals Complex



<sup>1</sup>Platinum group metals.

McKinsey&Company | Source: Company annual reports; McKinsey analysis

Diversification across metals and geographies simply exacerbates productivity losses and increases operational complexity. In other words, a coal miner (1.7% decline) diversifying into Platinum Group Metals (PGMs 4.5% decline) places itself at an even greater economic disadvantage given the atrocious levels of productivity in PGMs. Can you imagine the atrocity of the strategy if that coal miner's operation is in Latin American (4.1% decline) and the PGM asset acquired is in Sub Saharan Africa (4.5% decline)? Yet this sort of capital allocation happens all the time in the name of lowering risk, leading to Diversified Miners attracting a premium rating relative to single commodity miners. In the face of this evidence, shouldn't a copper mine in Latin America (Chile) in fact trade a premium to a diversified miner out of South Africa?

That the mining industry lags most other industries across the world in productivity, is not for lack of awareness of the problem by various company managements or attempts to address it. Analysis by Boston Consulting Group shows that over time, a full three quarters of productivity measures designed to transform the economics of mining companies fail. See Figure 6. The vast majority of such measures do not even take off! Most of those that do take off and work are short-lived, and only a quarter of all attempts succeed. Yet the payoff is well established; investors are prepared to reward companies who can sustain transformative productivity measures by bidding up their shares relative to the market.

Figure 6: Probability of Success of Productivity Measures in Mining



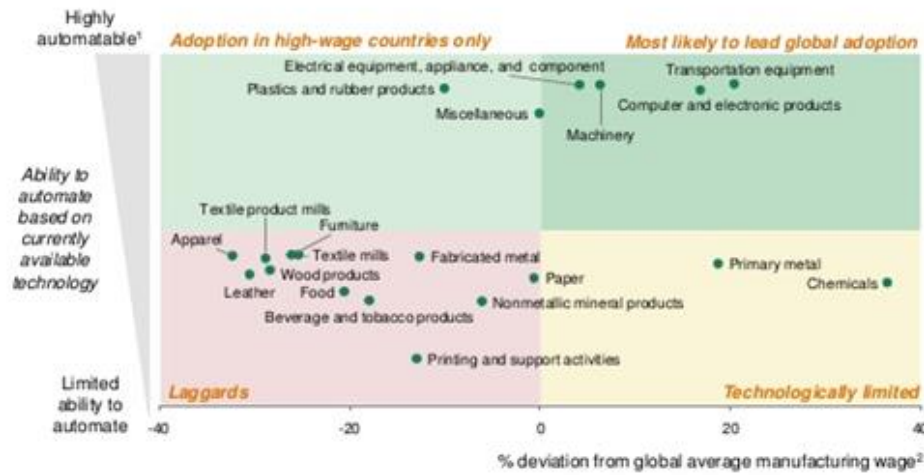
Source: BCG

The obvious risk for investors seeking to reward mining companies for enhancing productivity is that most measures turn out to be unsustainable. For instance, pulling back on capital expenditure and cutting operating costs certainly increases free cash flow in any one or two given years. However, those actions atrophy the business over longer periods. So while the market may reward the business for increased profitability, and we are in this period now, it does not hesitate to punish the company when it perceives loss of competitiveness.

Some investors would say that the issue is not whether productivity is anathema to the mining industry but rather whether it is possible to identify, and invest in, an exception to the rule. This is akin to looking for a diamond encrusted gold needle in a haystack. You'll pull out so many straws of hay from the stack as to create the impression it is a straw of hay that you're looking for! If you're looking for a diamond encrusted gold needle, why not go a looking for it in a stack of gold? The reason why the mining industry is not a "stack of gold", excuse the pun, is because there is a technological limit to the availability of innovative and creative tools to enhance and sustain its productivity.

It turns out that some industries are more amenable to productivity gains arising from technological innovations such as automation than others. For instance, not only is the adoption rate for automation in Electrical Equipment, Appliances, and Components very high, there is a plethora of technology available to employ in the industry. Cost savings from continuous improvements in productivity structurally drive down the price of electronic equipment, appliances, and parts. Think of the electronics industry in South Korea (Samsung, LG, etc.)

Figure 7: Automation Adoption Rates and Availability of Technology by Industry



<sup>1</sup>Corresponding to occupational tasks that have the future potential to be replaced with advanced robotics. <sup>2</sup>Average industry-specific wage premium derived from BLS International Labor Comparison of Hourly Compensation Costs in Manufacturing Industries, 2012.  
Note: Petroleum and coal manufacturing not pictured due to high and variable wage premium, consistent with immovable, resource-intensive industries.  
Sources: US Bureau of Labor Statistics, BCG analysis.

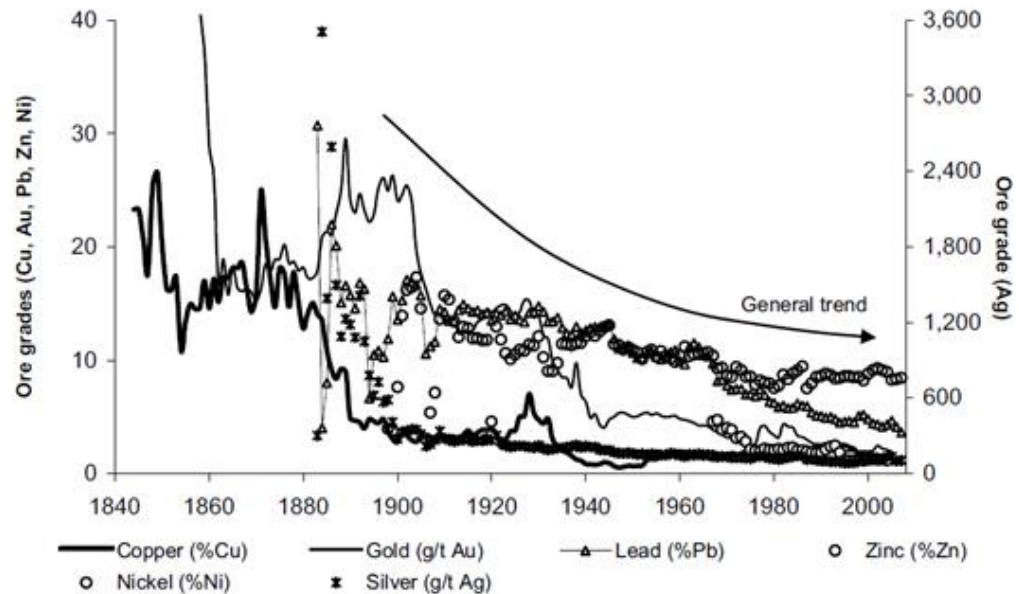
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Source: BCG

In contrast, there is not only a low adoption rate of automation in primary extraction (mining) but there is a limited amount of technology available to do so. See Figure 7. This is disappointing as one would expect (i) a unionized high wage sector with (ii) declining quality of underground reserves to be fertile ground for automated solutions (human ingenuity).

The latter point of the previous sentence -- falling grades -- is central to understanding why the upward trajectory of marginal costs is unrelenting. The quality of ore extracted from the ground has steadily declined for over a century and a half. The most profitable mine is one where you pluck metal from the earth's surface by hand. During the gold rush of the 19<sup>th</sup> century, you could see the metal with your naked eye! Naturally, the quality of grades declined as the good stuff got mined out first. See Figure 8. Over time, mines had to dig deeper to explore for acceptable quality ore to extract.

Figure 8: Ore Grades over Time

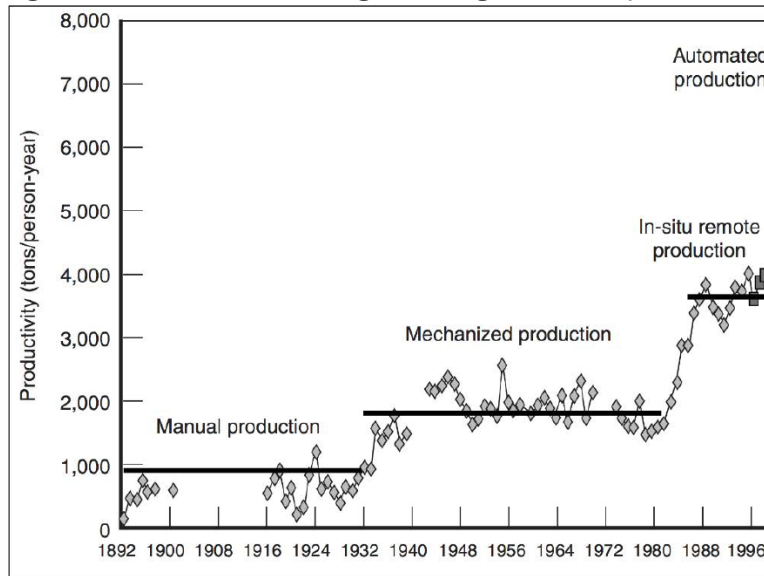


Source: "From Production to Sustainable Reporting" World Gold Council 2007, Gavin Mudd

Today, you have to move or disturb far more of the earth to extract the same ton of ore than you did back in 1840 or 1900. Imagine how much more it costs, given the paucity of automated solutions! The marginal cost of extracting one ton of ore is exacting on the profitability of mining companies.

The Holy Grail is to reduce marginal costs or increase tonnage per unit of costs (wages, capital, and non-labour operating expenses). Cutting costs might recalibrate costs in one or two years. But the idea is to rather incur costs albeit at a declining rate each year for every ton of ore mined. Figure 9 shows the progress in employing technology over the years to increase productivity – *Manual production* (1,000 tons per person per year), *Mechanized production* (2,000 tons per person per year), and *In-situ remote production* (4,000 tons per person per year). Automated production, the Holy Grail, when reached would result in between 7,000 tons per person per year. Naturally, improvements to automation would increase production in subsequent years with even lower additional costs (ever lower marginal costs).

Figure 9: Automated Mining: A Mirage or Reality?



Source: Peterson, LaTourrette & Bartis (2001, p.49). Image originally by Rand Corporation

The most advanced mining companies in so far as the use of technology, namely, Rio Tinto and BHP Billiton, are at the stage of "In-Situ Remote Production" where they use autonomous trucks and driverless trains operated from a remote control center. The gap however between where they are and fully "Automated Production" is highly technologically demanding with significant implications on the social license to mine if affected jobs cannot be employed gainfully elsewhere in or out of the mine.

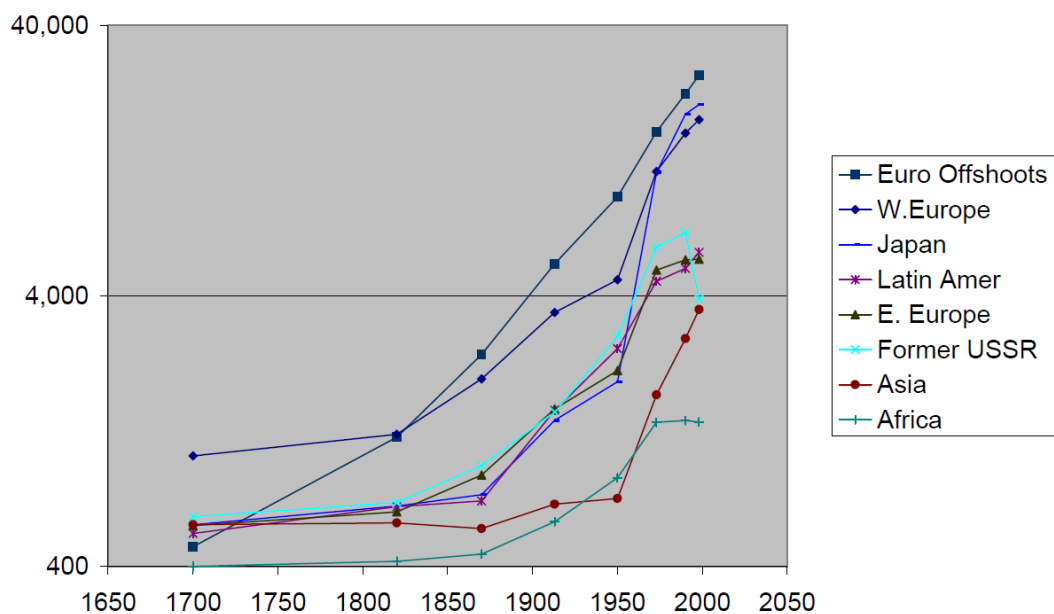
That industry makes investments and then writes them off in large quantities. Returns on capital not clearing the cost of capital is a sure sign of dependence (speculating) on commodity prices. Investors should pray for the day when capital expenditure is based *not* on assumptions of long run commodity prices (speculation) but rather productivity gains (investment). Management of mining companies like to point out products made of their metal that permeate our daily lives as their contribution to civilization. Investors pick it up from here to justify why there is always a price at which you can buy shares in a mining company. Both mine management and investors misunderstand the world.

Capital accumulation arising from the successful arbitrage of factors of production is the most important reason for economic development, our current civilization. An industry that impairs capital half the time it tries to do something does not contribute as much to better standards of living and quality of life as one that gets it right and grows capital. To illustrate, Anglo American Corporation, a large globally diversified miner with a portfolio of metals, has impaired 41% of cumulative capital expenditure and acquisitions since 2001. Placing all of the most brilliant scientists (engineers, biologists, chemists, physicists, and so on) in the world in one country without a capital structure is akin to asking them to sit idle. It sounds difficult to believe that civilizations can sit idle but recall that sustained long term economic growth at positive rates is a fairly recent phenomenon in human history, most of it having occurred in the last 200 years.

In the OECD paper, "The World Economy: A Millennium Perspective" Maddison Angus estimates that per-capita GDP in the world economy was no higher in the year 1,000 than in the year 1. In other words, the world was conspicuous by its inability to build capital, let alone reinvest it. People may as well have stood still for 1,000 years! Then something happened to per-capita GDP; it rose 53% from the year 1,000 to the year 1820, implying an annual growth rate of only one nineteenth of one percent over the latter 820 year period. This sloth like growth lacked productivity! Thanks to the spread of the Industrial Revolution out of Britain to other countries, the world growth rate started to rise sometime in 1820, averaging just over one half of one percent per year from 1820 to 1870, and peaking during what Maddison calls the "golden age", the period from 1870 to 1913 when it averaged 2.93% per year. By 2000, world per capita GDP had risen to more than 8.5 times its 1820 value.

Economic growth has been uneven not only across time but also across countries. Since 1820, living standards in Western Europe and its offshoots in North America and the Antipodes have raced ahead of the rest of the world, with the exception of Japan, in what is often referred to as the "Great Divergence". As shown in Figure 10, the proportional gap in per-capita GDP between the richest group of countries and the poorest group (as classified by Maddison) grew from 3 in 1820 to 19 in 1998.

**Figure 10: Per Capita GDP, 1990 International Dollars.**



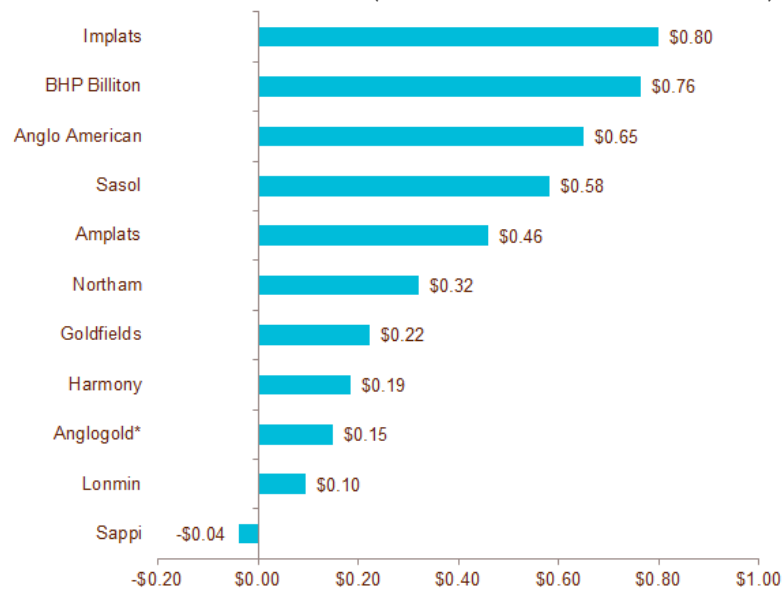
Source: "The World Economy: A Millennium Perspective" Maddison Angus

The leading industrial nations of the world spend large amounts on R&D aimed at generating innovations. In the United States, for example, R&D expenditures constituted between 2.2 and 2.9 percent of GDP every year from 1957 through 2004. But not much cutting-edge R&D takes place outside these leading countries. In 1996, for example, over 90% of the world's R&D expenditure, as measured by UNESCO, was done in just 8 countries. In their paper, "The Effect of Financial Development on Convergence" published in 2005 in the Quarterly Journal of Economics 120, Aghion,

Howitt and Mayer-Foulkes posit that financial constraints may prevent poor countries from spending at a level needed to keep pace with those at the frontier of R&D.

If, as we have just learnt, capital accumulation is a necessary precondition for economic value creation, then capital impairment must lead to value destruction. Since the year 2 000 to date, every dollar (US) of capital invested by listed mining companies has shrunk to 60c (US). Figure 11 shows the track record of destruction in capital investment among South African miners.

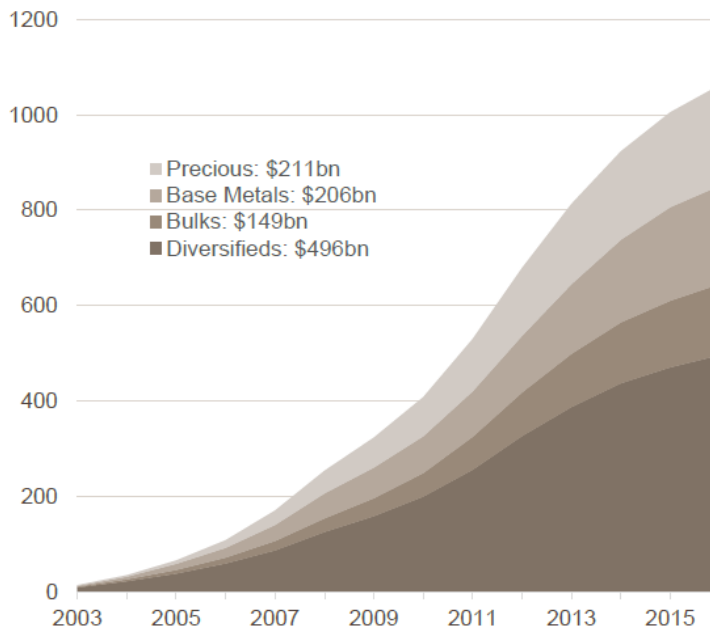
**Figure 11: Return to Shareholders per \$1 of invested cash flows, 2000 – 2016**  
(Net book value accretion and dividends)



Source: First Avenue, Morgan Stanley

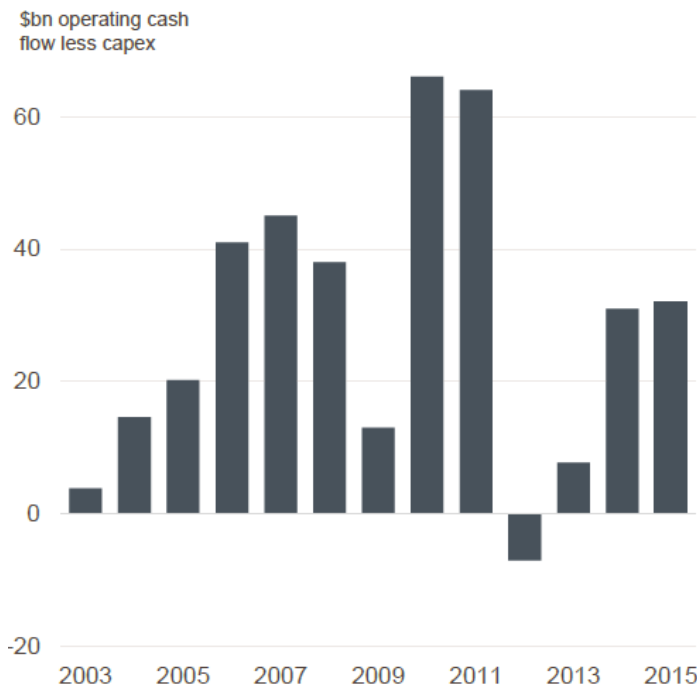
Far from being South African, this problem permeates the entire industry. During the commodity super-cycle early in the 21<sup>st</sup> century, the sector globally invested US\$1 trillion in capital expenditure between 2003 and 2015 (see Figure 12). As a consequence of losses and impairments, the investment equated to \$370b in free cash flow over the same period. (see Figure 13).

**Figure 12: \$1 Trillion Mining Sector Capital Expenditure, 2003 - 2015**



Source: Glencore BMO Global Mining Conference Presentation

**Figure 13: \$370b Free Cash Flow, 2003 - 2015**



Source: Glencore BMO Global Mining Conference Presentation

Capital destruction on such a grand scale, despite the commodity super cycle of 2005 – 2008, is directly due to productivity losses. Wealth is never created where productivity fails. We saw that between the years 1 and 1,000. Today the mining industry has an abundance of sources of capital to tap into (capital markets), an abundance of labour, capital equipment, and end markets. Sadly, none of them really matter without productivity.

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