

Gauging the Long-Term Cost of Gold Mine Production

By Mark Fellows, Managing Director, GFMS Mine Economics

What is the 'true', fully loaded cost of global gold mine production, and what factors decide it?

In this article, we aim to quantify the long-term equilibrium price required to sustain the industry.

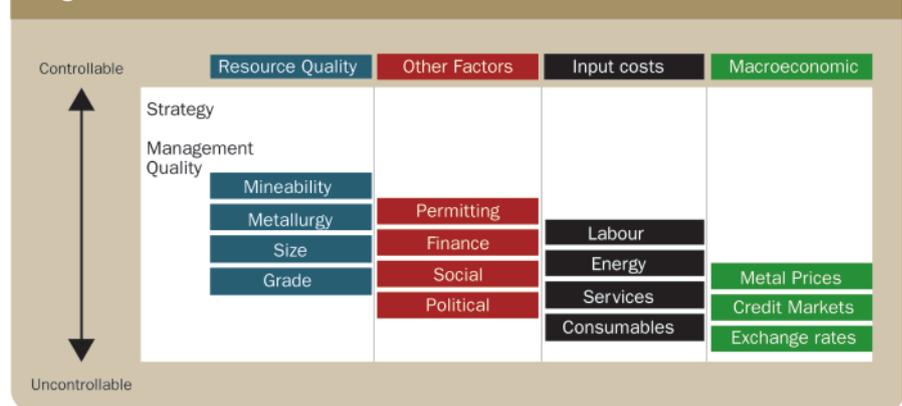
We also examine the impact of changes in the main production cost drivers: orebody quality, input costs, currency value and metal prices.

Believe it or not, gold mining is not a simple activity. Despite the archetypal image of a basic industry, with grizzled miners toiling away shifting dirt, gold mines are in fact highly complex, dynamic systems. Multiple controllable and non-controllable factors, some of which interact in unpredictable ways, affect output levels and profitability. To add to the complexity, global gold mines are heterogeneous, varying widely in geology, scale, technologies and cost structure.

As a result, considerable care must be taken when analysing, summarising and prognosticating about the industry. Bearing that in mind, this article draws upon the analysis in GFMS's Gold Mine Economics service to reach some conclusions about the long-term economics of the sector.

The Gold Mine Economics service comprises detailed mine-by-mine analysis of reserves/resources, production, operating costs, capital costs and cash flows for more than 300 gold mines and projects, with historical data and forecasts to 2030. By benchmarking detailed technical, operating and financial parameters, we aim to provide the best possible insight into the drivers of the industry's cost structure. Based on a stringent methodology for analysing mine operating costs, analysis is

Figure 1: Drivers of Gold Mine Economics



derived from a 'bottom-up' understanding of resource quality, orebody geometry, mining and processing methods, labour costs, productivity, energy usage and consumable input costs.

The Drivers of Gold Mine Profitability

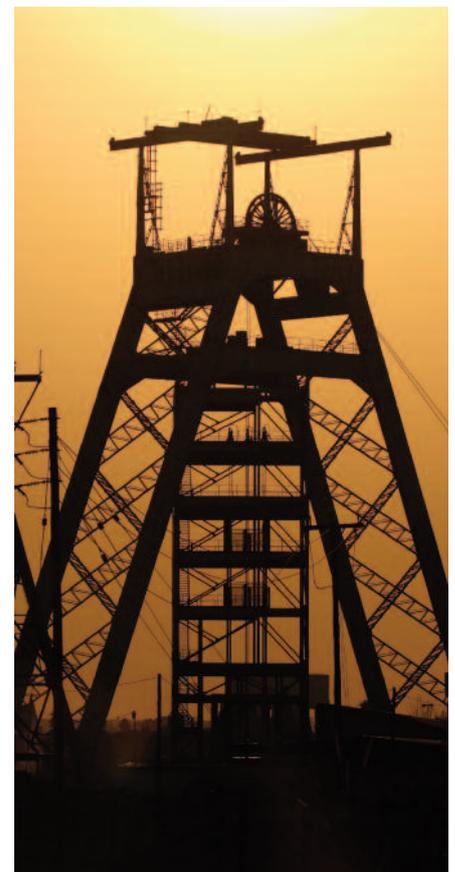
Figure 1 shows the main factors that interact to dictate the profitability of a gold mining operation. At first glance, the diagram would seem to imply that few of the drivers can be significantly influenced by mine management, but this is not really the full story, as the relative importance of the factors shown varies enormously.

Strategy is the overriding factor, dictating the scale of operation, mining and processing techniques used, and mine lifespan. This is in turn dependent on resource quality, which is to some extent uncontrollable, but a key point in this regard is that resource size and grade can be influenced by strategy. How much is management willing and able to invest in exploration ahead of production? What cut-off grades do they select?

Cut-off grade selection is arguably the main factor deciding the economics of a mine, as it dictates the tonnage and grade of ore to be mined, and in turn the scale, lifespan and profitability of the operation. Cut-off grade is defined as the lowest grade of ore that it is economically feasible to extract, and it in turn depends on forward-looking metal prices, operating parameters and cost assumptions made by mine management.

Cut-off grade provides the mechanism by which miners respond to changing metal prices. If prices rise, they can extend mine life

by reducing cut-off grade, exploiting previously uneconomic mineralisation. This has the effect of extending mine life, while lowering gold output and causing costs to rise. Some mines are inherently more flexible than others, with larger, higher-grade, 'massive', near-surface orebodies having significant advantages in this regard.



As gold prices have risen roughly five-fold since 1999, average gold mine ore grades have fallen by nearly 30%, in large part due to this cut-off grade response. This also partly explains why gold mine production has not increased significantly, as producers have focused instead on extending their mine lives. This has been exacerbated by a 'discovery drought', with very few world-class gold orebodies being discovered in recent years, despite record exploration expenditure. Over the same period, all-in production costs have more than doubled, partly due to severe input cost inflation, but also due to lower cut-off grades.

Figure 2 shows the sensitivity of gold mine production costs to the main drivers, on a global average basis. For instance, a 10% fall in global average ore grade gives rise to a \$50/oz rise in average production costs.

Besides grades and process recoveries, production costs have the highest sensitivity to changes in exchange rates, with a 10% strengthening of the dollar giving rise to a \$47/oz fall in average production costs on a global average basis. Exchange rates are usually the largest single determinant of year-on-year global average production cost changes.

With regard to input costs, labour is by far the most sensitive cost component, by virtue of its large proportion of a typical operating cost base.

Production Cost Metrics: What's Useful?

GFMS contends that the gold mining industry's historic preference for reporting and comparing cash cost parameters, rather than adopting a profitability measure that is more reflective of the true, 'fully loaded' costs of production, has ultimately proved misleading and counterproductive.

The fixation on cash costs has fostered a general perception that global gold mine margins are higher than is actually the case.

All-in cost is a proprietary GFMS Mine Economics \$/oz cost metric, designed to reflect the full marginal cost of gold mining. In addition to mine site cash expenses (mining, ore processing, on-site general and administrative costs), refining charges, royalties and production taxes, by-product credits, depreciation, amortisation and reclamation cost, it includes ongoing capital expenditure, indirect costs and overheads. The latter includes corporate administrative costs, interest charges, mine site exploration and any extraordinary charges, such as retrenchment costs, carrying value write-downs, etc. Ongoing ('stay-in-business') capital expenditure

is defined as capital expenditure necessary to sustain production rates at a mine. The global average all-in cost for 2009 was \$717/oz, up \$27/oz on 2008.

The fixation on cash costs has fostered a general perception that global gold mine margins are higher than is actually the case.

Although cash cost measures such as total cash cost are a useful gauge of competitiveness at the mine-by-mine level, they do not account for a substantial portion of the cost required to develop and sustain gold mining operations, so are arguably less useful as a measure of 'real' industry margins, or the long-term gold price required to incentivise gold mine production growth.

The historic relationship between all-in costs and gold price paints a clear picture. During the 1997 to 2001 bear market, average all-in cost margins were strongly negative, with costs tracking the gold price downwards in an effort to regain profitability, or at least remain

in production. As the gold price recovered from 2002 onwards, positive all-in cost margins were quickly re-established and maintained. However, until 2009, miners were unable to deliver sustained production growth, given that they were reducing cut-off grades to take advantage of higher prices, extending mine life at the expense of higher costs.

Implications for Long-Term Prices: The Future

Although all-in cost is undoubtedly a superior measure of 'full' industry production costs, we admit that it does not account for certain cost components that also have a bearing on the true long-term break-even cost of gold mine production.

All-in costs include sustained/ongoing capital expenditure and depreciation of sunk capital costs, but not current-year project development and expansion capital costs. In 2009, the gold mining industry invested an average of \$173/oz of global production in project development and mine expansion.

Figure 2: Sensitivity of Production Costs to Key Drivers

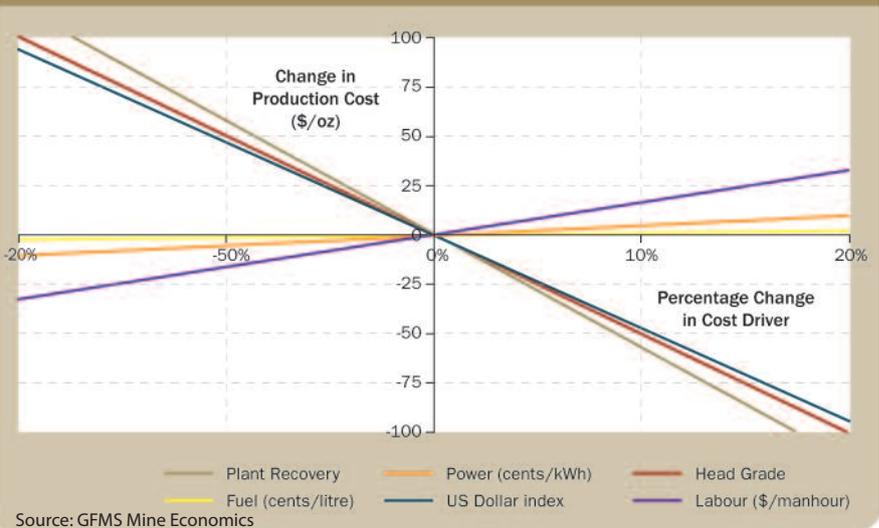
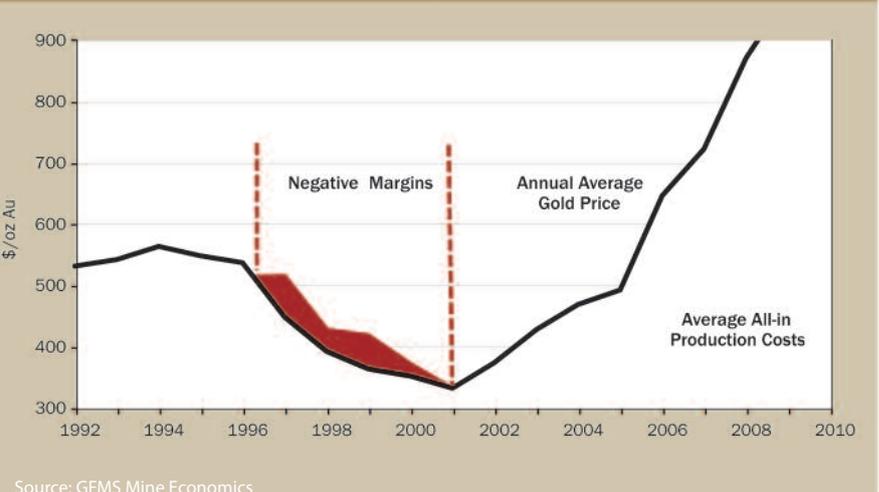


Figure 3: All-in Cost versus Gold Price (rebased to 2009 \$ terms)



When Germany introduced the Gold Standard in 1871, our company had already been a world leader in precious metals for 20 years . . .



Berlin
1871
Hanau
1851



140 years later we are still setting the standards when it comes to precious metals expertise.

Precious Metals Trading. Refining. Investment. Industrial Products. An entire world in just one word: Heraeus.

At one time precious metals were the currency of the world. Even today they are still treated and traded as financial products; globally, unrestricted by place and time. For just as long, precious metals have also played a vital role in a manifold of industrial applications.

Heraeus has played a vibrant role in both areas for almost 160 years, and during this time our company has earned a reputation as a leading expert and competent partner for the refining, trading and manufacturing of precious metals.

Strongly supported by our four trading units in Hanau, Hong Kong, Shanghai and New York, we assist our customers in professionally managing the risks associated with the physical acquisition, price fluctuations or financing of precious metals.

In addition, our company also offers a large number of products to investors: A wide range of gold, silver, platinum and palladium investment bars, from a filigree 1 gram gold bar right up to a massive 5 kg silver ingot, can satisfy the wishes of any physical investor.

Hanau

tradinghu@heraeus.com

Phone +49 6181.35-2750

Hong Kong

tradinghk@heraeus.com

Phone +852 2773 1733

Shanghai

tradingsh@heraeus.com

Phone +86 21 33575675

New York

tradingny@heraeus.com

Phone +1 212 7522180

www.heraeus-trading.com

Likewise, all-in costs exclude greenfield (i.e. early-stage project) exploration expenditure, which is estimated to equate to \$35-\$60/oz of annual production. Taking these additional costs into account, GFMS Mine Economics contends that the 'true' long-term cost of gold mine production stood somewhere between \$925 and \$950/oz in 2009, a sobering thought when one remembers that this figure does not allow for any return to shareholders.

Long-term equilibrium production costs will remain highly sensitive to the key cost drivers, some of which are partially within managements' area of influence or control, but most of which are uncontrollable. Many of



these cost drivers will doubtless continue to creep upwards in future. The largest single cost component, labour costs, continue to rise; for instance, in local currency terms, South African labour costs have increased by 10% per annum on average since 1999, with the two-year agreement signed by the main producers in 2009 committing to ongoing 7.5-10.5% wage increases. There is undoubtedly a tendency, now established, toward increasing unit labour costs in developing countries, as globalised mining companies export better operating practices, along with higher productivity levels and better pay.

Similarly, other input costs will continue to rise in real terms, as energy and consumable costs are pushed upward by increased competition for resources, and greater regulatory and tax burdens, such as carbon taxes.

This said, as highly complex dynamic systems, well-managed gold mines will continue to adapt, utilising whatever flexibility is provided by their orebodies. Despite record exploration expenditure, the extent to which this will be bolstered by the discovery of new world-class deposits over the coming years remains to be seen. ■



Mark Fellows is *Managing Director of GFMS Mine Economics. Mark began his 23-year career in the mining industry as an exploration geologist with Anglo American/De Beers. He went on to work for several junior*

explorers, prospecting for diamonds, gold, base metals and industrial minerals in Africa. In 1992, he joined Brook Hunt, a globally renowned mineral economics consultancy, serving as a director, responsible for BH's Gold Mine Costs study and numerous bespoke consulting assignments from 1999 to 2005.

GFMS Mine Economics was launched in early 2009, with aim of delivering high-quality, detailed insight into the economics of mine production, exploration and development, across a broad range of metals and minerals.
mark.fellows@gfms.co.uk

Toronto Dominion Bank

Tim Gardiner heads the Global Precious Metals team at TD Securities. He's joined by **Steve Scalossi**, **David Swinburne** and **Matthew Hopkins** in Toronto; **Bob Davis**, **Peter Airlie** and **Alex Pop** in London; and **Ruark Lineker** and **Joe Bowden** in Singapore.

Christian Pfeifer to UBS

Christian has joined UBS to trade PM Spot. He will be based in London. He previously worked at Mitsui London and prior to that Heraeus NY.

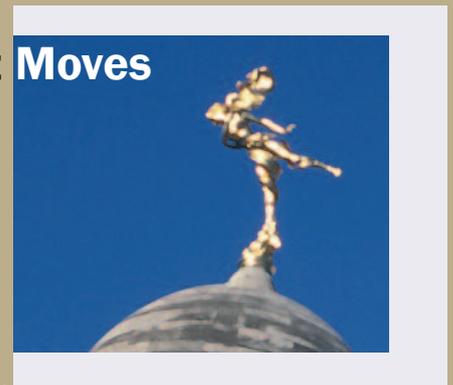
Lucien Weisen to Commerzbank

Lucien started his banking career at UBS Luxembourg as an FX trader in 1984, covering the forward books as well as precious metals for wealth management. After 14 years at UBS, he moved to Dresdner Bank Luxembourg to cover the same role for the next 12 years. In April 2010 he joined Commerzbank's precious metals desk in Luxembourg, where he covers Spot and Forwards.

David Corcoran to Société Générale

David started at SG in late August. He previously worked at Dresdner Bank, Credit Suisse, JP Morgan and Johnson Matthey Bankers.

Market Moves



John Reid to Metalor Technologies SA

John has joined Metalor as Group Treasury. He previously worked as Head of Global Markets for the Rand Refinery in South Africa and prior to that worked for Barclays Bank, ABN Amro and Nedbank amongst others.

Jamie Grace to Standard Chartered

Jamie has joined Standard Chartered as Head of Metals Options Trading. He is based in London and with the Commodities Derivatives Team. Jamie has 16 years' experience trading financial derivatives and previously worked at Calyon as Head of Commodity Option trading, and at JPMorgan for 12 years, where he held the position of Global Head of Oil Option Trading.