What Commodity Price Should I Use in my Model ?

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Introduction

As resource bankers, one of the most frequently asked questions by mining engineers is "What commodity price should I use in my model?" Most mining engineers either pluck a number out of the air "which feels right" or use a price which has been decreed as correct by the upper echelons in the company. A good estimation of future commodity price has positive impact on most aspects of mine planning such as break even cut-off grade analysis and pit optimisation.

This paper will focus on some of the issues to consider when estimating a conservative life of mine gold price. The same principles (with some variations) apply to other precious metals and base metals such as silver, copper and nickel. These commodities have sophisticated and deep forward markets which allow a producer to lock in the price of future production over a number of years. Other minerals such as coal and industrial minerals rely on marketing to secure individual sales contracts and will not be discussed in this paper.

There are a number of ways which a company may reduce price risk by locking in or hedging forward prices over a portion of the mine life. However, for credit reasons it is not usually possible to hedge the price of 100% of the mine production over 100% of the mine life.

Methods of hedging fall into two broad categories, Forward Sales and Option Schemes. It is desirable to secure the forward price of the commodity which you are mining. A secure forward price enables better mine optimisation and planning.

A bank lending money for the development of a mining project will insist on a minimum amount of hedging to ensure that a minimum commodity price is realised over the period that the loan is to be repaid. High cost, low operating margin producers are implicitly more sensitive to any movement in commodity prices and it is essential that they hedge their production if they are to remain viable in times of low commodity prices.

What is Hedging?

Hedging is a method of securing a future commodity price, exchange rate or interest rate through the use of the forward market and or financial derivatives.

Hedging Products

There are a number of products which can be used to secure the forward price of a commodity, these fall into two broad categories, Forward Sales and Option Schemes. Commodities can also be sold at **spot** which means they are sold now at the current market price and the sale is usually settled within two business days.

Forward Sales

A forward sale is where a producer enters into a contract to deliver a certain quantity of a commodity to a purchaser at some time in the future for a certain price. The producer has a **contractual obligation to sell** the product at the nominated date. The forward sale price may be at a price which is higher than spot, at spot or at a price lower than spot.

Gold Forward Sales

Gold is relatively unique in that the forward price of gold is usually higher than the spot price. The reason for the forward sales price being higher than the spot price is due to an interest rate differential between gold borrowing rates and cash deposit interest rates.

The following example demonstrates why the forward price for gold is usually higher than the current spot price. In simple terms the following events take place when a producer enters into a forward sales agreement with a bank;

1. The producer decides to enter into a forward sales agreement with a bullion bank to deliver say 1,000 ounces of gold in 12 months time.

2. The bank goes out to the market and borrows 1,000 ounces for twelve months at an interest rate of say 2.0%.
3. The bank then sells the gold at spot (say $450) and deposits the cash (say $450,000) and earns say 6.0% on the deposit.
4. The bank is then earning 4.0% more on the cash deposit than it is paying on gold it borrowed.
5. When the producer delivers the gold, the bank uses it to repay the gold it borrowed and then delivers the cash plus the additional 4.0% to the producer.

Therefore the value of this forward contract accrues 4.0% per annum. This increase in value is called **a contango**. The main risk for the bank is that the producer can not deliver the gold at the end of the 12 months. If that is the case then the bank has to go to the market and buy gold at spot and repay the gold it borrowed. This constitutes a credit risk for which the bank charges a margin.

In the past 4 years contangos have varied between around 0% and 6% and are commonly around 4%

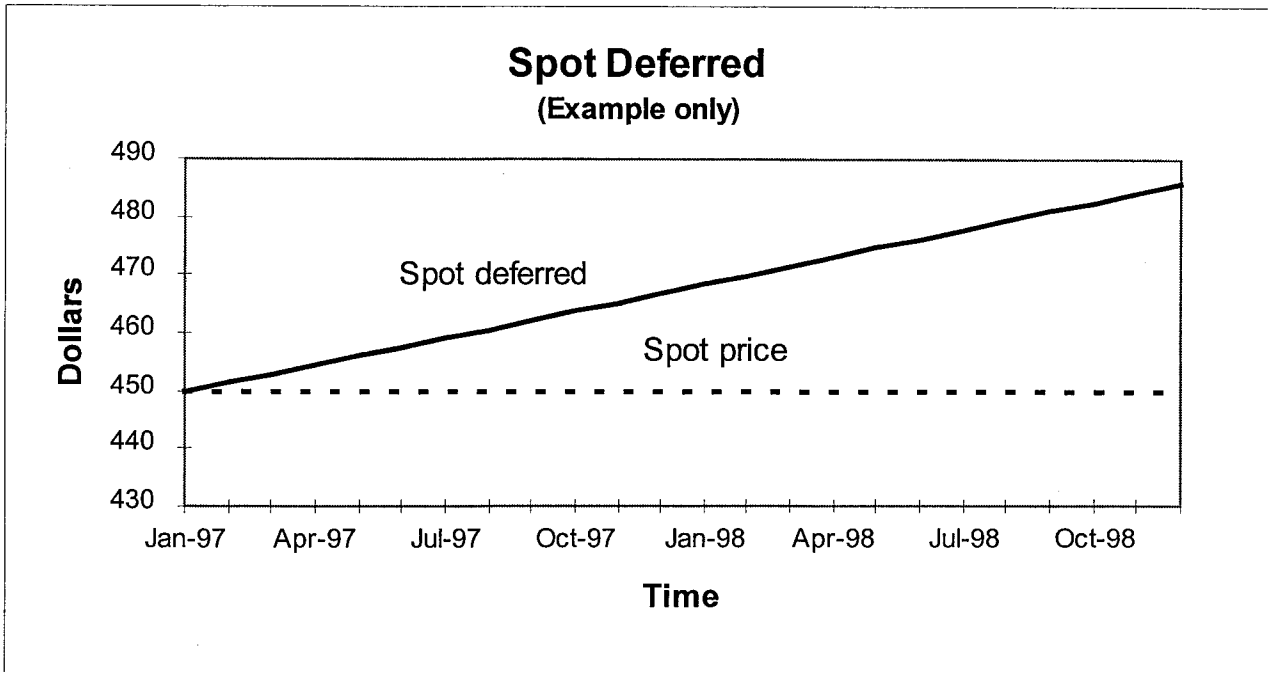
If the gold interest rates where higher than the cash deposit rates the forward price would be less than the spot price, this is called **backwardation.** Backwardation is rare in the gold market.

Spot deferred

A spot deferred is a forward sales contract in which a producer will commit to delivering a certain quantity of gold over a period of time. It is not important when the gold is delivered only that the final delivery is made before the expiry date of the hedging facility.

For example a producer may produce 100,000 ounces over three years then he may put 75,000 ounces on spot deferred and as he produces he delivers gold into the contract. The remaining portion of the spot deferred contract continues to accrue a contango until the final ounce of gold is delivered.

A spot deferred has the following profile:

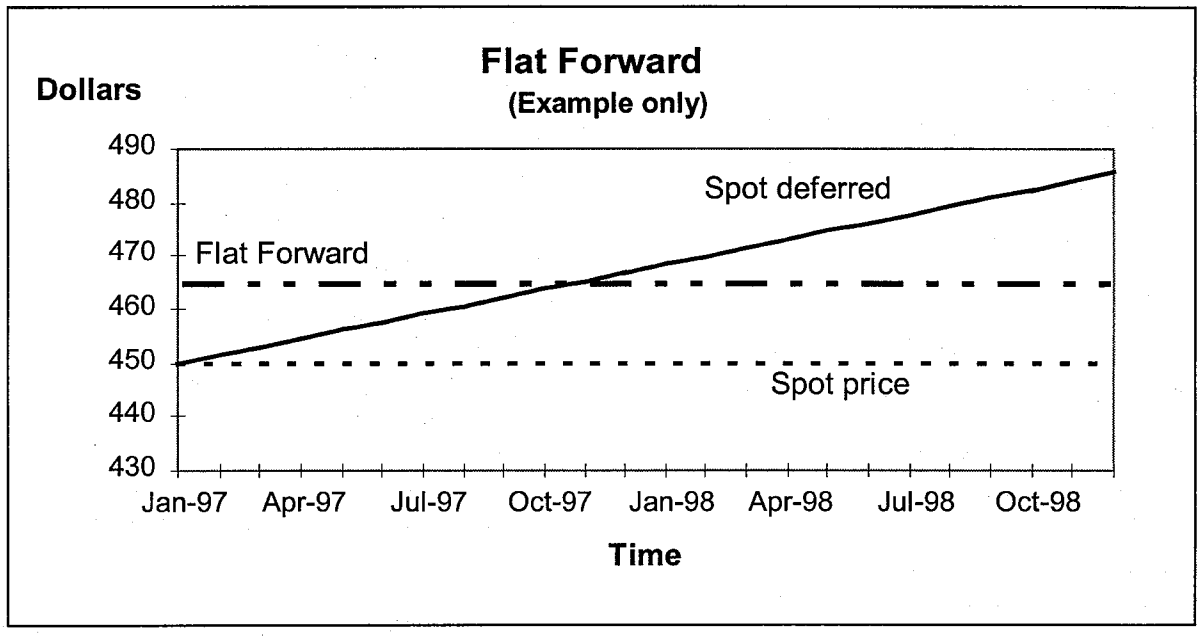


A Flat Price Forward

A flat price forward hedging program takes the spot deferred profile and flattens it so that a producer may make a series of deliveries at the same price over the period of the hedging program.

A flat price forward effectively takes some of the benefit of the contango in the later half of the program and brings it forward to the first half of the program.

A flat price forward has the following price profile:



Fixed Price Forward

An alternative to a spot deferred or a flat price forward is a fixed price forward, where a producer enters into a contract to sell a certain amount of gold at a certain price on a certain date in the future. The advantage of the fixed price forward and flat forward is that the producer knows exactly how much he is going get for his gold at a certain date in the future.

Closing out forward sales contracts

Any of these structures can normally be unwound or closed out during the life the programme.

If at the time that the forward sales contract is closed the spot price is lower than the present value of the hedging contract then the hedging has some value (in-the-money) and the producer will receive some money when the hedging is closed out.

If the spot price is higher than the present value of the hedging contract (out-of-the-money) then it will cost the producer some money to close out the hedging.

Options

There are two types of options, Put Options and Call Options.

European Put Options

If a producer was to **buy a put** option he would have the **right but not the obligation** to **sell** a certain amount of gold, at a certain price at a certain date in the future. The cost of buying and option is called the **option premium**.

If on expiry of the put option the spot price is less than the strike price of the option then the producer will deliver the gold into the option.

If on expiry the spot price is higher than the strike price of the option then the option falls away worthless and the producer may sell at spot.

A producer may also **sell a put** in which case he has an obligation to buy gold at a certain date in the future. The seller earns a premium for selling the option.

European Call Option

If a producer was to **buy a call,** he would have the **right but not the obligation** to **buy** a certain amount of gold at a certain date in the future.

A producer may also **sell a call,** in which case he would have the obligation to sell gold at a certain date in the future.

Option Pricing

The cost to buy an option is called the **option premium**. The option premium may be calculated using a number of option pricing formulae (most commonly the Black and Scholes formula) which take into account:

- The current spot price
- The strike price
- The interest rates (currency and gold)
- The time period to expiry of the option
- The volatility of the gold price

In general the longer dated the option the more expensive it is. Put options become more expensive as the strike price is increased and call options become more expensive as the strike price is reduced.

Option Programs

Put and call options can be structured into a huge array of hedging programs from simply buying put options to complex structures involving both buying and selling puts and calls. There is a branch of finance which is solely involved in financial engineering of derivatives and is beyond the scope of this paper.

One common option strategy is called a zero cost collar where a producer sells call options and uses the premium generated from the sale of the calls to buy put options. The put option protects the producer from falls in the commodity price. Selling calls at an acceptable strike price provides a cap where if the commodity price goes above the strike price of the call then he will be required to deliver into the call option.

Maximum and minimum hedging

Maximum hedging

It is not normal for a producer to be able to hedge 100% of its reserve base. This is because of the inherent risk that the ore reserve calculation may be wrong and production is lower than projected. The amount of hedging a producer may do is directly related to the quality of the minable reserves.
A bank may allow a producer to hedge up to 75% of its proven and probable reserve. The rest of the production is normally sold at spot.

There is an active forward market for gold to allow forward sales for up to 5 years on a fixed basis and almost indefinitely using floating interest rates.

Hedging other metals

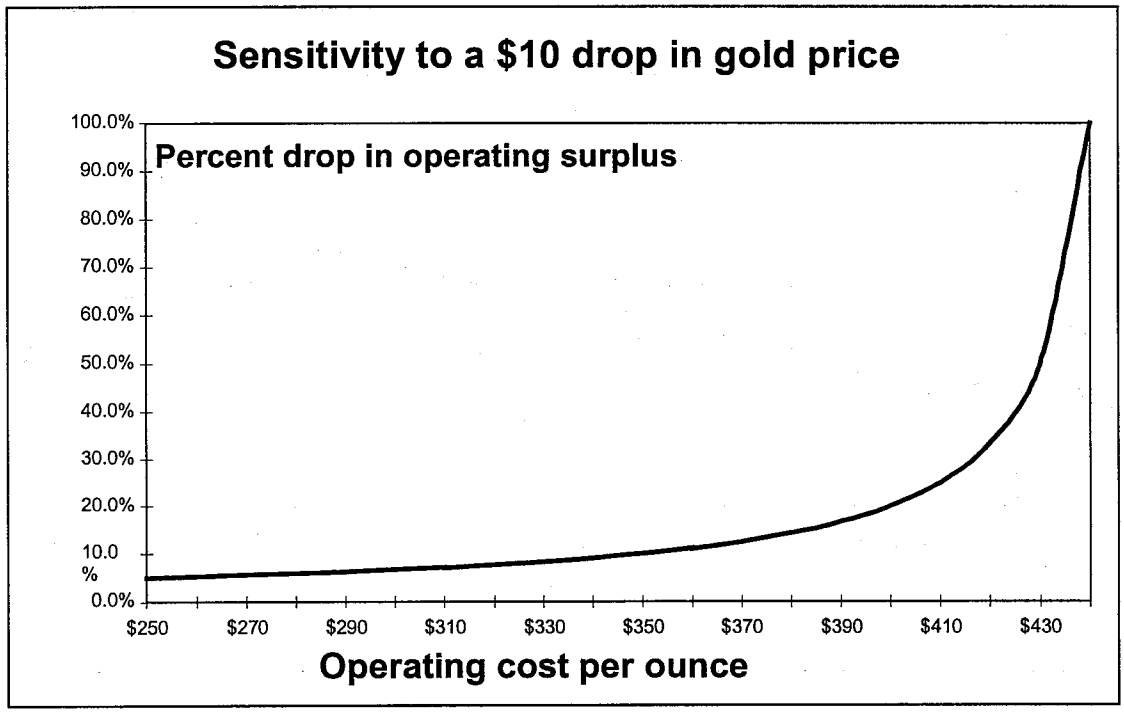
Copper zinc and aluminium have liquid forward markets for 27 months on the London Metals Exchange (LME). Tin lead and nickel have liquid forward markets for 15 months on the LME. If a producer wishes to enter into longer dated hedging then a bank may be able to artificially engineer a market beyond the existing forward market.

Minimum hedging

It is good operating policy to put sufficient hedging in place to cover a mine's operating costs. So that at any time if the spot price drops below the break even cost of the mine then the producer can deliver into its hedging contracts and remain in operation.

If a bank lends money for the development of a mining project it will normally stipulate that the producer must hedge a minimum amount to cover repayment of its loan and to cover the mines operating costs during the life of the loan.

Simple economics dictates that the smaller the operating margin the more sensitive a project is to movements in its commodity price. Therefore high cost, low margin operations should hedge more than low cost more profitable operations.



Hedged prices and pit optimisation (Spot Vs Hedged Price)

Hedged prices should only be used in pit optimisation if the mining company already has hedging in place or there is a reasonable probability that the hedging will be put in place.

Pit Optimisation at Spot

A conservative price should be used for pit optimisation if the pit will be only marginally profitable. In this case it is advisable to optimise at spot. If the pit design appears viable at spot then a higher weighted average price achieved through hedging will provide a margin of safety in the pit design. If all goes well then the hedging will provide some additional profitability. Therefore optimising at spot results in a more robust reserve.

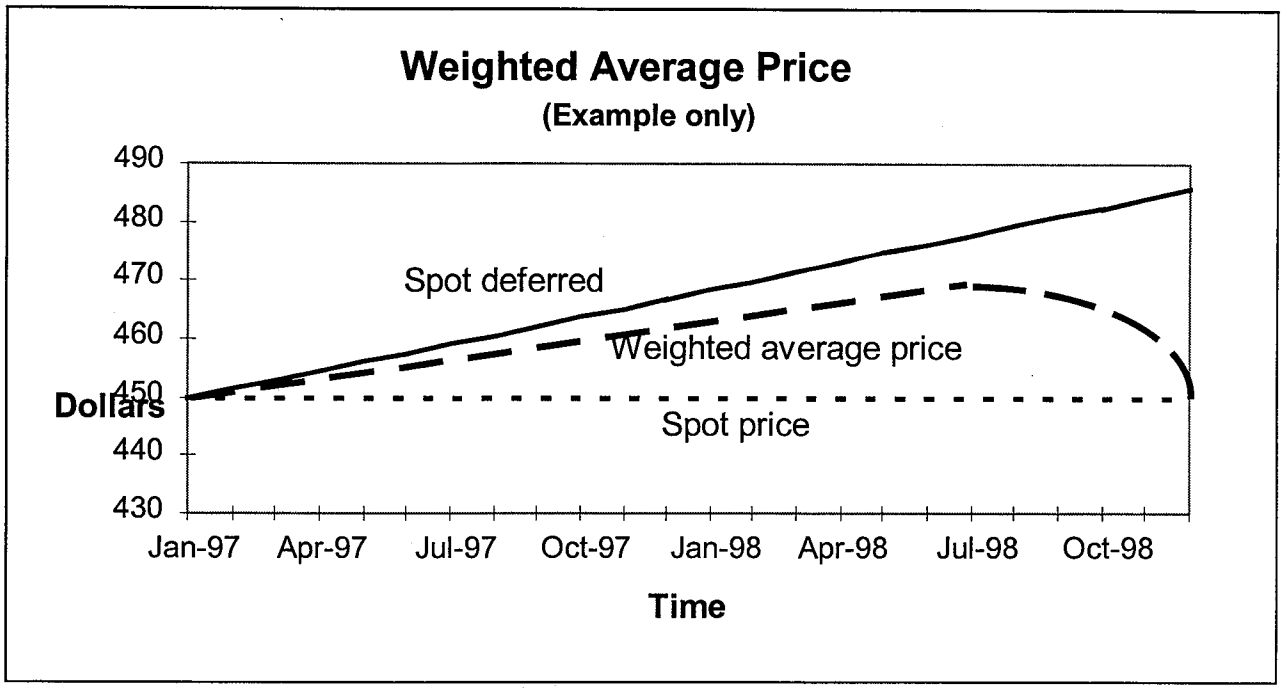
Pit Optimisation at hedged prices

If hedging is factored into the price that is used for pit optimisation then some ore which is uneconomic at spot is likely to be drawn into the ore reserve. This will usually result in a larger pit with a higher stripping ratio and lower grade reserve. It is important to determine what weighted average price is realistically achievable.

Achievable weighted average price?

It is important that if hedged prices are used that it is acknowledged that only a portion of the reserve can be hedged and the remaining reserve must be sold at spot. This provides a weighted average price somewhere between spot and the hedged price. A realistic rule of thumb when deciding on a gold price to complete an optimisation is to assume that 75% of the proven and probable reserve can be hedged for the mine life. The remaining production should be assumed to be sold at the current spot price.

The following graph demonstrates the weighted average achievable gold price for a mine that has a two year mine life. The final price achieved will be between spot and the price achieved for the portion of production sold forward taking into account the accrued contango.



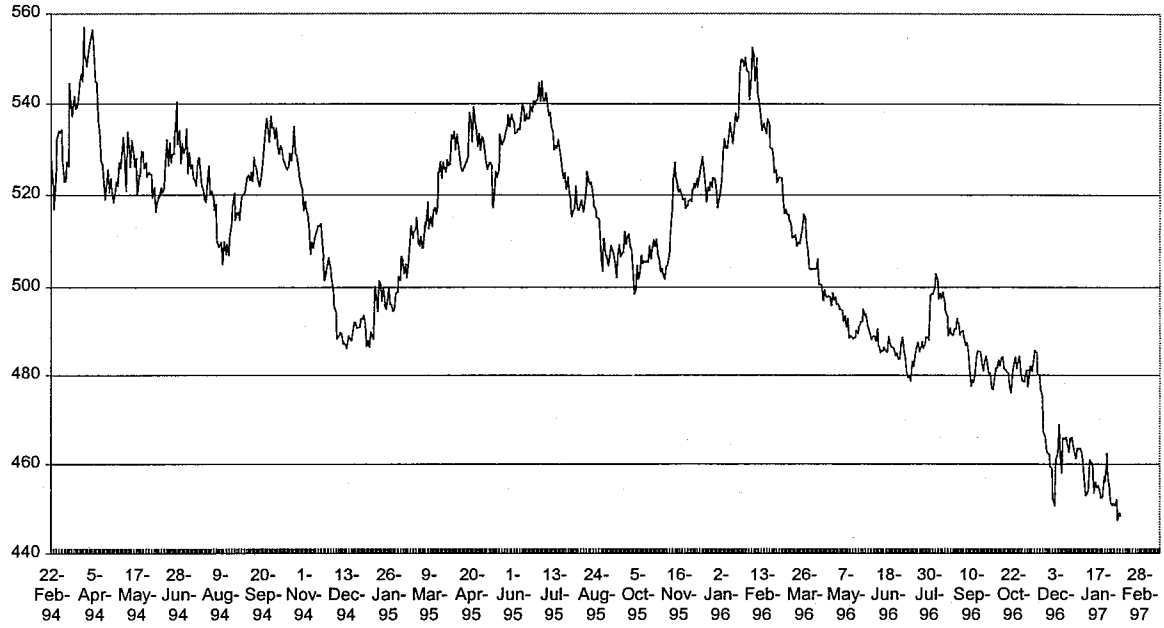
The graph assumes that 75% of reserves are hedged on spot deferred at the beginning of a two year mine life and that gold is progressively delivered into the hedging over the life of the mine.

Conclusions

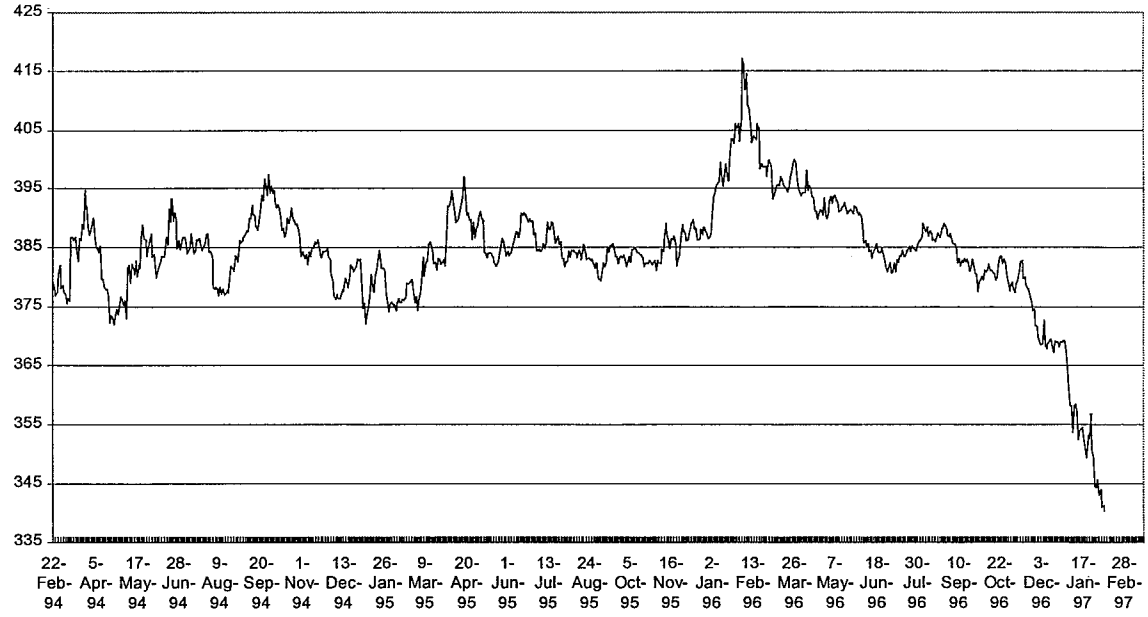
Hedging is a means of reducing the risk of adverse movements in the commodity price in a mining project. In general hedging provides for a higher weighted average price. Orebody cut-off modelling and pit optimisation should be done at the current spot price unless the company already has hedging in place. If the company has hedging in place then it should not be assumed that 100% of the mine's production can be sold at the higher hedged price.

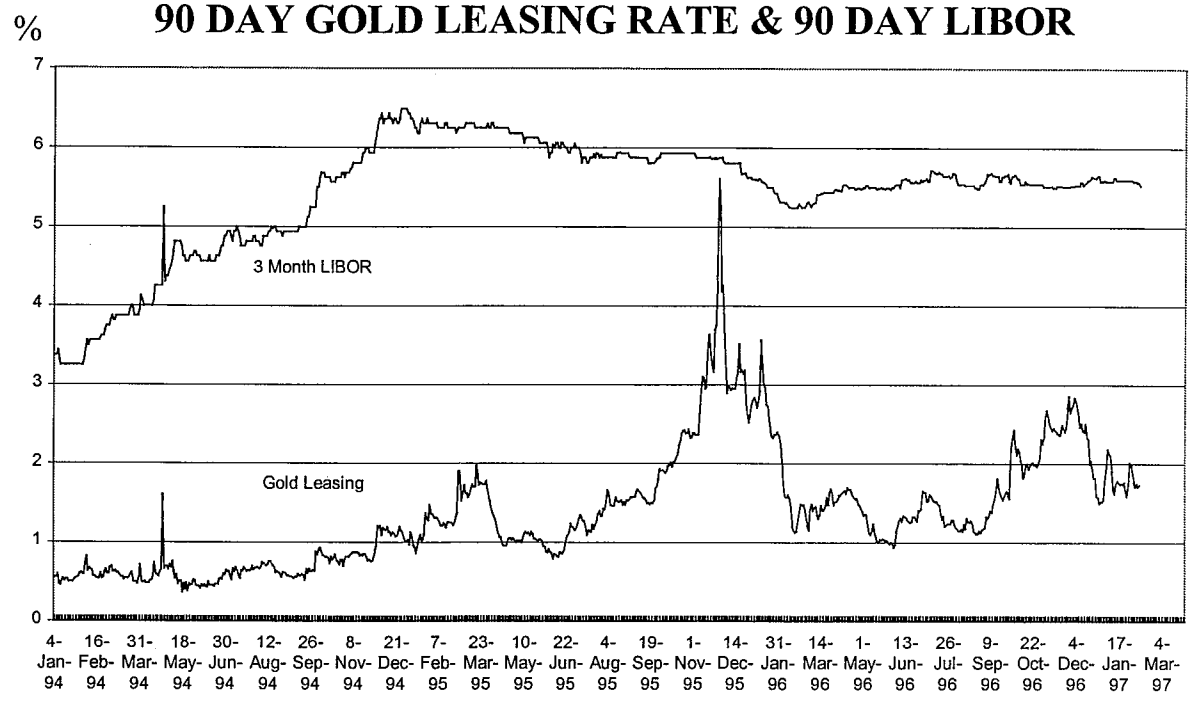
Appendix

Australian Dollar Gold Price



US $ Gold Price





Note: LIBOR is the London Interbank Offering Rate for US Dollars.

Gold Leasing Rate is the gold interest rate.