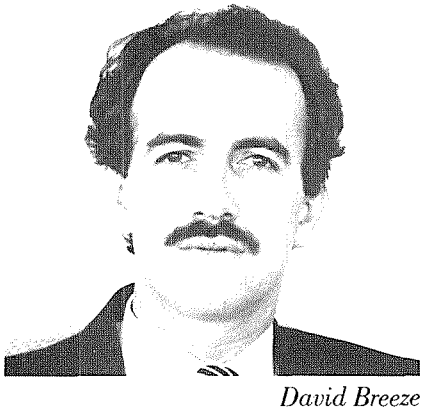
# THE TAMING OF THE GOLD INDEX

## FINDING OUT WHAT MAKES IT MOVE

*by DAVID BREEZE and MARK STONE*



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***A statistical examination of the factors affecting the gold index has produced a model which may give operators a clearer view of the behaviour of the markets.***

This paper describes a mathematical analysis of selected fundamentals of returns to Australian gold producers and their relationship to the gold index. The analysis was carried out in December 1987 and January 1988. The original model was compared with current data in April 1988.

From an examination in December 1987 of the overlaid time graphs of the gold index and the gold price (in $US) over 51 weeks, it appeared that the gold index had been heavily oversold (see Graph 1). However, the uncertainties and share-price fluctuations of this period indicated a need for a closer examination of the factors involved.

This initial graph was extended to include the longer time span of four years and three months (see Graph 2).

Once again it appeared likely that the index had been oversold, although not to the extent apparent in Graph 1.

An examination of the longer-term graph suggested that an intuitive explanantion was insufficient to explain the relationship between the two factors and that a mathematical analysis might well assist in determining this relationship. Could we, in fact, devise a model which provided a clear and readily usable method to assist prediction of the gold index?

The two graphs raised a series of questions:

- What other factors are related to the index (for example, cost of production or exchange rates)?
- Is the index more dependent on the gold price in $A or $US?
- Over how long a period should analysis be conducted?
- Would looking at the factors on a Y-vs-X basis be more helpful than time graphs?

To help answer these questions, all available data up to November 1987 for a total of 19 economic factors were collected (see Table 1). For about half the factors, data were available back to October 1978 (nine years), and for the rest between four and eight years' data were available.

The analysis was conducted so as to:

- select related factors based on market experience;
- evaluate the correlation between these factors and the index;
- evaluate the fundamental links between correlated factors and the index;
- formulate a model or models based on correlated factors which are fundamentally linked;
- draw inferences from the models as to the current level of the index.

Four mathematical models were developed from statistical analysis of the gold price ($A), cash operating cost of production ($A), the $A/$US exchange rate and the trade-weighted index (TWI).

The models cover the range from "optimist" to "pessimist", giving an index which fits actuals in a price-range for gold

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of $480 to $500 (based on early January 1988 prices). The best fit for the current market was considered to be Model IV (see Tables 3 and 4): Gold Index = 5.59 x gold price ($A) − 16.5 x operating cost ($A) − 655 x $A/$US + 29.9 x TWI + 527.

Model IV was applied using daily average values to ascertain how suited it was to current data. The model, which was developed on monthly average data to November 1987, was found to fit from January to April in 1988 remarkable well (see Graph 4).

When the data were initially graphed against the gold index it appeared that some of the points could be termed "outliers." These points related to the period from March to October 1987, when gold shares were generally believed to be overheated. Three new data-sets were formed to ensure that the analysis was not unduly biased in this overheated period, and to allow for:

- the effects of floating the Australian dollar in December 1983;
- the proliferation of goldmining activities from early 1984 onwards; and
- the more efficient production methods which also became widely used about this time.

The resulting four data-sets are:

I 78/87 I: All data, outliers included

II 78/87 E: All data, outliers excluded

III 84/87 I: January 1984 to November 1987, outliers included.

IV 84/87 E: January 1984 to November 1987, outliers excluded.

The four sets of data were statistically analysed to determine the correlation coefficients (see Table 1). A coefficient of +1 or −1 means the data plots along a straight line; 0 means there is no correlation.

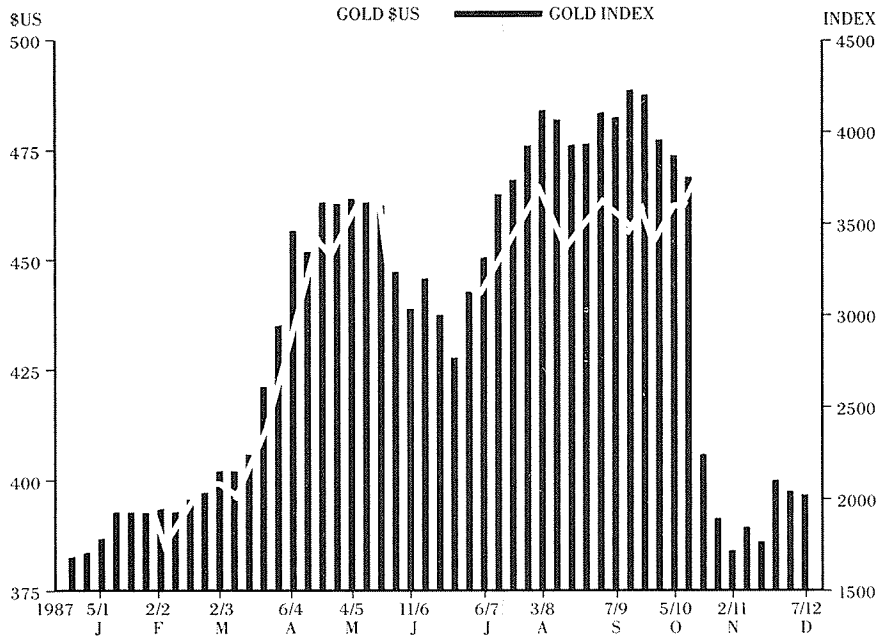
A comparison of the 78/87 data with the 84/87 data indicates that the $A gold price correlates well with all four data-sets. However, this is not so for the $US gold price or $US gold futures; this may have been caused by the floating of the exchange rate in late 1983.

Most of the factors selected correlated with the gold index and attention was directed to factors with coefficients greater than +0.5. The 10-year bond was a notable exception, with a low correlation.

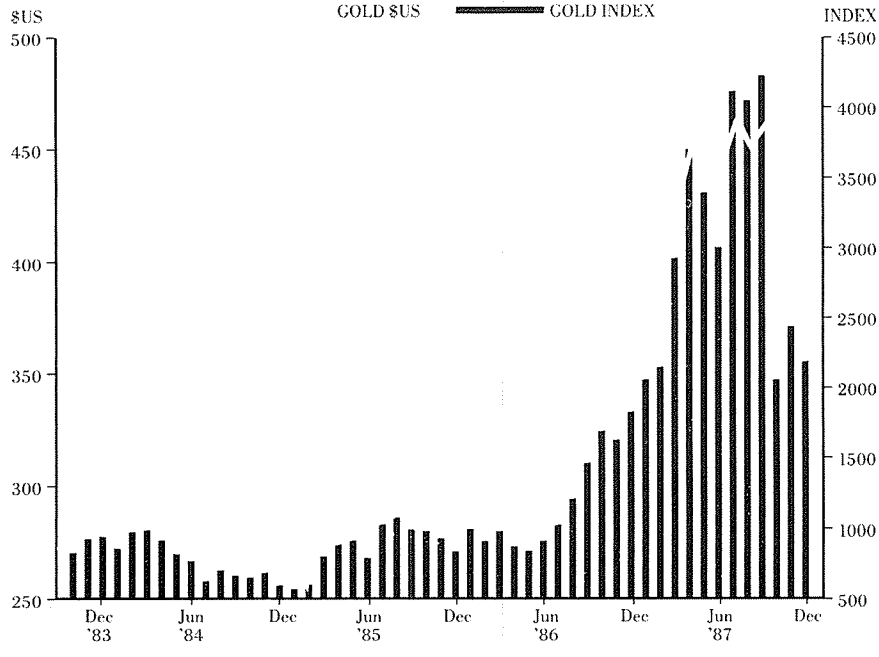
As expected, positive coefficients were obtained for the gold prices, the all-ordinaries index and overseas indexes. When the gold prices or indexes rise, the gold index usually rises. It would be expected that the general level of investor confidence would be reflected in both the all-ordinaries and gold indexes. The coefficients for the exchange rates and TWI are negative as the devaluation of the Australian dollar increases the effective selling price of gold and hence increases miners' profits.

The all-ordinaries futures and gold futures did not have significantly better correlations than the physicals. As futures data were available only for shorter periods, the use of physicals was preferred.

**GRAPH 1: Gold index and $US gold price Dec. 1986 to Dec. 1987**




**GRAPH 2: Gold index and $US gold price Oct. 1983 to Dec. 1987**




The high correlations apparent between the gold index and most of the factors mean that we should now look at fundamental linkages between the index and the factors to enable factors to be selected for inclusion in a model.

## Fundamental factors

The gold index is currently composed of a weighted aggregate of the market capitalisation of 49 of the leading goldmining companies. The index is directly related to the market capitalisation of the companies and therefore to the future returns from

**TABLE 1: Factors contributing to data-sets.**

| | I 78/87 I | II 78/87 E | III 84/87 I | IV 84/87 E |
|---|---|---|---|---|
| Gold $US | .20 | .22 | .85 | .79 |
| Gold futures $US | .54 | .37 | .81 | .73 |
| Gold $A | .73 | .75 | .80 | .87 |
| Production cost $US | −.74 | −.72 | −.74 | −.72 |
| Production cost $A | −.50 | −.47 | −.50 | −.46 |
| $A/$US | −.65 | −.59 | −.68 | −.68 |
| $A/Yen | −.68 | −.61 | −.63 | −.69 |
| $A/UK pound | −.49 | −.37 | −.57 | −.66 |
| $A/D-mark | −.63 | −.47 | −.66 | −.75 |
| $A/Swiss franc | −.66 | −.53 | −.66 | −.75 |
| TWI | −.63 | −.59 | −.57 | −.65 |
| 10-year bond | −.18 | −.14 | −.35 | .12 |
| All-ordinaries index | | | | |
| physical | .92 | .80 | .94 | .84 |
| 3-months futures | .92 | .74 | .95 | .83 |
| 6-months futures | .92 | .75 | .95 | .82 |
| FT100 | .82 | .67 | .90 | .71 |
| Dow | .87 | .74 | .89 | .77 |
| NYSE | .84 | .74 | .86 | .71 |
| Tosho | .86 | .70 | .92 | .85 |

**GRAPH 3: Gold index and $A gold price 1984-1987**


holding their shares.

Although it is self-evident, it needs to be pointed out for the purposes of model definition that future returns arise from the profits generated by goldmining activities, and that net profit equals total revenue less cash operating costs and non-cash and administration costs. Cash operating costs, not including capital costs, were used for the purposes of the analysis, because reliable historic data for other cost components were not available.

The gold index is therefore fundamentally linked to gold prices and the cost of production. The index should rise as prices rise and as costs fall. The market capitalisation of a gold producer usually equals a multiple of earnings (i.e., P/E ratio), hence it is expected that the index should rise by a multiple of similar size; that is, the regression coefficients for gold price and cost should be of similar size to the P/E ratios. As a reduction in cost is morely likely to be long-lasting than an increase in price, it is likely that the multiple for cost changes will be greater than that for price changes. Further, a reduction in operating cost can greatly increase the size of reserves as cut-off grades are lowered. Operating costs used in the analysis are derived from research by Benney Partners.

## Models

After examining all 19 factors, a model was selected incorporating these four:

- gold price (in $A);
- cash operating cost of production ($A);
- $A/$US exchange rate; and
- trade weighted index (TWI).

The TWI was included to enable the model to recognise the value of the Australian dollar relative to a range of foreign currencies.

The models were generated by the statistical techniques of multiple regression, which weights the various factors according to their correlation with the index and their correlation with each other. The technique alone does not imply that any given factor causes the index to be a particular value. Causation is usually inferred on the basis of correlation and fundamental linkages.

Computer difficulties caused by the outliers prevented the fitting of a line to data-set "78/87 I". The three remaining data-sets were fitted as follows:

**II (78/87 E):** Index = 3.05 x gold price ($A) − 9.86 x operating cost ($A) − 1866 x $A/$US + 22.8 x TWI + 1646. Multiple correlation coefficient: 0.81.

**III (84/87 I):** Index = 12.3 x gold price ($A) − 69.9 x operating cost ($A) − 2642 x $A/$US + 108 x TWI + 5691. Multiple correlation coefficient: 0.88.

**IV (84/87 E):** = 5.59 x gold price ($A) − 16.5 x operating cost ($A) − 655 x $A/$US + 29.9 x TWI + 527. Multiple correlation coefficient: 0.91.

## Trends

The models are similar. However, several trends are apparent. The impact of higher gold prices, lower production costs and lower exchange rates is generally greater in the data from 84/87, particularly in III (84/87 I). The signs of the coefficients are as expected (price positive, cost and exchange rate negative), except that a negative sign for the TWI coefficient would have been expected. This departure is apparently caused by the complex interaction of the TWI and the exchange rate.

## Extrapolations

The use of regression equations to predict the index from today's data is fraught with all the perils of forecasting. History may not accurately predict the

future, relationships between factors may change over time, and new factors may appear or old factors become irrelevant.

Nevertheless, a "predicted gold index" was calculated to enable a comparison with the current index (see Table 2). This comparison provides some insight to how the market behaved under differing conditions. In addition, the effect of variations in gold price and other factors can be studied.

In Table 2, Model II (78/87 E) can be argued to provide a lower prediction of the gold index because of the effect of data from 1978 to 1983, when the exchange rates were fixed, causing lower profits, production costs were high and mining activity was relatively slow.

Model IV (84/87 E) gives a higher prediction of the index and the prediction is the closest to the actual value. This model is considered more representative than the others of the market in early 1988.

Model III (84/87 I) is more representative of a bullish market and also illustrates the magnitude of the bull run which pushed the index to a mean value of 3963 for September 1987.

***These values do tend to provide a light at the end of the tunnel for the optimists.***

Table 3 illustrates the effect of a gold price of $US500, a further $5 fall in cash production costs, and three different exchange rates. These values do tend to provide a "light at the end of the tunnel" for the optimists!

Another simple test of Model IV is to see what value of index is indicated when the gold price equals the total cost of production. A value of $A350 for the gold price gives a predicted value of the index close to zero, which is theoretically valid.

**GRAPH 4: Actual gold index and model calculation Jan-Apr 1988**

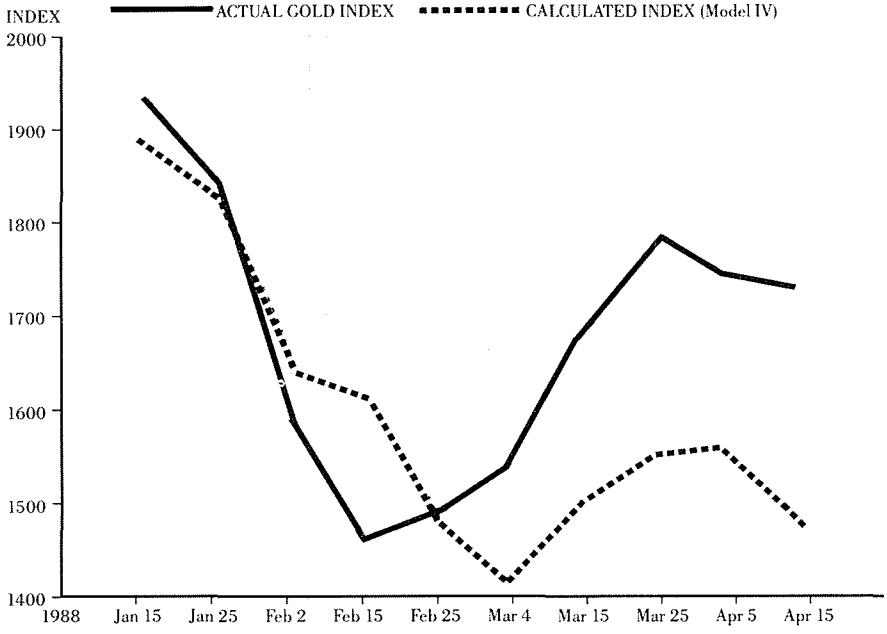



**TABLE 2: Comparison of models.**

| Model | Gold model prediction | Index actual | Gold price $A | Production costs $A | $A/$US | TWI |
|---|---|---|---|---|---|---|
| (II) 78/87 E | 1447 | 2037* | 677* | 215 | .712* | 52.0* |
| (IV) 84/87 E | 1850 | 2037* | 677* | 215 | .712* | 52.0* |
| (III) 84/87 I | 2719 | 2037* | 677* | 215 | .712* | 52.0* |

* mean for period 1/1/88 to 12/1/88

**TABLE 3: Model IV — effects of changes in factors.**

| Model | Gold index prediction | Gold price $A | Production costs $A | $A/$US | TWI |
|---|---|---|---|---|---|
| (IV) 84/87 E | 2345 | 746* | 210 | .67 | 52 |
| (IV) 84/87 E | 2147 | 714* | 210 | .70 | 52 |
| (IV) 84/87 E | 1966 | 685* | 210 | .73 | 52 |

* equivalent to $US500

## Conclusion

Statistical models can be fitted to the data and the best of these models "predicted" a gold index close to the levels of early January 1988. This model is: Index = 5.59 x gold price ($A) −16.5 x operating cost ($A) − 655 x $A/$US + 29.9 x TWI + 527.

Based on predictions of a gold price of $US500, cost of production of $A215, exchange rate of 0.70 and a TWI of 52, the best model suggests that the gold index should rise from its levels of early January. The models have been generated on the basis of monthly averages and this should be remembered when using a value at a particular time.

This paper is not intended to be a definitive statement, but rather to raise and review certain factors which affect the gold index, and which may assist in the development of future models to give market operators a clearer understanding of the relationships involved.

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