

# Behavior of Gold Mining Equities: Gold Prices and Other Influences

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The behavior of gold related equity securities such as common stock in gold mining companies has long been considered to be dominated by changes in the price of gold itself. While the gold price is the single most influential force in determining the behavior of gold mining shares, gold stocks are not nearly as sensitive to gold prices as current financial models suggest they should be. This apparent contradiction is explained by the extraordinary sensitivity of gold mining stocks to an exogenously defined measure of investor confidence. This result was first obtained using comparisons of the behavior of gold with that of gold mining stocks. It was then separately observed through a macroeconomic model of security returns in which gold price is not an included variable.

The first test was to calculate a "gold beta" which would measure the sensitivity of returns on gold stocks to changes in the price of gold. Ordinary least squares regressions were performed using monthly percentage changes in gold prices as the independent variable and percentage total returns to an index of precious metals mutual funds as a proxy for gold mining stock prices. The index used was the J&J Precious Metals Mutual Fund Index (8). The index consists of all open-end mutual funds investing in precious metals. We did not use the widely published Standard & Poors gold mining industry index, as this index is constructed from just a couple of US domestic gold mining companies, whereas the index of funds encompasses a wide range of equities from both US and foreign mines as well as a large variety of companies. As such, the fund index was judged less susceptible to distortions due to company specific events.

For the period from June 1968 through September 1993, the gold beta for precious metals stocks was .77 ( $t = 7.97$ ). Additional regressions using individual gold oriented mutual funds and individual gold related stocks yield similar results. This result is both unremarkable and remarkable. It is unremarkable as the regressions clearly confirm the commonly held belief that the general behavior of gold stocks is extremely reliably related to the behavior of prices for gold itself. What is remarkable is that slope values or gold betas are so low.

Consider means by which to estimate the value of a share of stock in a gold mining company. A simplistic approach would be to take the current price of gold and subtract from it the estimated cost of mining each ounce of recoverable gold in the ore body. This would give the potential profit of the mine per ounce of recoverable gold. One need now only multiply by the assumed number of recoverable ounces of gold to get the value of the mine. Dividing by the number of shares outstanding, we would obtain an estimate of the value for one share of stock.

Putting realistic numbers into the formula, the remarkable aspect begins to take shape. Assuming that the price of gold is \$400 per ounce and direct mining costs are \$300 per ounce. The gross profit is \$100 per ounce. Note that the value is linearly related to this gross profit. If the price of gold changed to \$500 per ounce (a 25% increase), the gross profit would be \$200 per ounce, and the forecast price of the stock would rise 100%. The percentage change in valuation of the equity position is four times as great as the percentage change in value in the commodity asset. This

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suggests that the gold beta should be around four, not the .77 to 1.22 range which has been historically observed.

At first the above formulation appears over-simplified. However, this structuring of the problem follows directly from the Hotelling Pricing Principle (1), and its corollary, the Hotelling Valuation Principle which was described by Merton and Upton (2). Under the Hotelling principle, the real price of an exhaustible commodity can be expected to rise over time at a rate equivalent to the real rate of interest. The net present value of the resource does not vary with the time of extraction. The market value of a unit of the unextracted resource can therefore be determined solely from the current market value of the extracted resource less the marginal cost of extracting the resource. Valuation techniques based on the Hotelling principle were found to be effective for the equities of companies holding oil reserves in (2), and such methods are applied to valuation of gold related in securities by McDonald and Solnik in (3).

What this formulation of the problem does not consider is the possibility of changes in costs being positively correlated with changes in gold prices. Changes in mining costs may arise in two ways. First, workers and suppliers are most likely to request increases when company operations are known to be very profitable. Second, to the extent that the ore body is heterogeneous, the company may choose to mine portions of the ore which are more difficult or expensive to extract during periods of high bullion prices, while reserving more cheaply mined ore for periods when end product prices are lower. Corporate managements in many industries use such strategies to "smooth" company earnings.

Another piece of the explanation is the use of hedging techniques by mining companies. By engaging in future delivery contracts, many mining companies lock in prices for upcoming production, so that near term profitability is not impacted by changes in gold prices. But this can account for only a small part of the anomalous stability of gold stock prices. Few companies hedge more than a year in advance, while the large ore bodies mined by major companies are usually quite long lived, lasting twenty-five years or more. As an example, the ore body which initiated the founding of Homestake Mining was still being mined in 1990, after more than one hundred years.

Many such refinements have been considered by other researchers such as Pindyck (4), Brennan/Schwartz (5) and Sundresan (6). Using any of these more rigorous methods with realistic data still leads to the conclusion that gold betas should be near the inverse of the percentage operating margins of the mining company, rather than near one as is observed. Miller and Upton (2) do make a rationale for the "oil beta" of oil companies being around one, but this argument is dependent on the special tax treatment of oil companies.

As of November 31, 1993, the aggregate market value of gold mining equities publicly traded in the U.S. was \$22.3 billion. Using average gold prices during 1992 and aggregate 1992 revenues for these companies, we estimate that US producers produced about 335 metric tonnes of gold bullion in 1992. To judge from production statistics from the November 1993 issue of *Gold Demand Trends* (11), that production figure represents about 15% of 1992 world production from mining. Assuming that US mines are using their reserves at the same rate as other producers, it would suggest an aggregate value of all mining properties on the order of \$140 billion. With bullion in the

\$350 to \$400 per ounce range, and estimated world reserves of one billion ounces (10), we obtain an estimated production cost of \$200 to \$250 per ounce by using the Hotelling process in reverse. These values appear to be close to actual production costs at this time, suggesting that the Hotelling procedure is, in fact, a reasonable starting point.

Another possible explanation is that gold stock investors believe that gold prices are mean reverting, suggesting that any current price increase is more likely than not to be followed by a decline, and that declines are more likely than not to be followed by increases. Statistics do not bear out this notion, because from June 1968 through September 1993, a regression of gold price against the previous monthly change obtains a slope coefficient of .12 ( $t = 2.16$ ). Note that the coefficient is significant different from zero at the .05 and the sign of the slope is positive, indicating a trending rather than a mean reverting series. Using data from January 1985 through September 1993, a very slight mean reverting tendency is observed but it is far too weak to be statistically significant.

Two macroeconomic forces are conventionally cited as the primary causative variables in the behavior of gold. The first is inflationary expectations, and the second is the level of international economic and political instability. Both of the conventional views for the respective impacts on gold prices are readily illustrated. If we assume that yields on long term bonds are an adequate proxy for inflationary expectations, we would expect that changes in gold prices would be positively correlated with changes in yields and hence negatively related to monthly total returns. Using the period from November 1984 through September 1993, we obtain a regression slope of  $-.25$  ( $t = -1.94$ ) for gold price percentage changes versus the Lehman Brothers Long Term Government Bond Index and a slope of  $-.49$  ( $t = -1.95$ ) for the gold stock proxy against the same government bond index.

The second proposed economic explanation, however, yields our first surprising result. The selected proxy for economic uncertainty was the total return of high-yield or "junk" bonds. When the economic picture seems rosy, investors are lured by the high promised yield of these bonds and junk bonds outperform bonds in general. When, in contrast, investor confidence is at an ebb, one would expect that investors would abandon junk bonds for the safety of higher quality securities. Given the conventional view of gold's role as a monetary reserve asset and a store of portable wealth through the ages, the expected performance of gold would be negatively correlated with junk bond behavior. We then tested this hypothesis. The junk bond time series was the Merrill Lynch High Yield Bond Index which begins in November of 1984. From that date through September 1993, a regression of gold returns versus junk bond returns yields a slope of  $-.48$  ( $t = -2.02$ ), which is both of the expected sign and statistically significant at the .05 level. However, a regression of our gold mining stocks proxy against junk bond returns yields a positive  $.68$  ( $t = 1.49$ ) slope for the same period. In this instance, the sign suggests that the changes in gold mining equity prices are positively correlated with junk bond returns.

Given the rather weak significance of this result, the analysis was extended back to March of 1969 using a different proxy for the independent variables. In this second effort, an index of government bond mutual funds represented government bond returns and an index of junk bond mutual funds represented junk bond returns. Over the longer time frame, changes in gold prices were effectively uncorrelated with government bond returns with a slope of  $-.13$  ( $t = -1.01$ ) but the slope between

gold mining stock returns and junk bond returns was .85 ( $t = 4.10$ ) a conclusive result suggesting that gold mining stock returns were strongly and positively correlated with junk bond returns.

To further clarify the independent effects of changes in inflationary expectations and changes in investor confidence, the following procedure was performed. We began by constructing a new index consisting of 80% Treasury bills and 20% the Lehman Brothers Long Term Government bond index. This proportion was determined by finding the combination of the two treasury security indices whose combined return time series yielded the minimum variance when compared to the return series of the Merrill Lynch High Yield Index. The technique used was a quadratic program that yields weighting coefficients that are constrained to be between zero and one, and which must sum to one. For details of the technique see Sharpe (7). In essence, we were trying to construct a government bond index with interest rate sensitivity similar to that of the junk bond index. The differential returns between the junk bond index and this newly constructed index must primarily arise from the changes in the spread in yield between Treasury quality and "junk" quality, as they have similar responses to changes in the interest rate state.

A multiple regression was now performed using the gold fund index returns as the dependent variable and four independent variables: % monthly change in gold bullion price, % S&P 500 stock index total return, % total return to the 80/20 Treasury security index described above, and % total return to the Merrill Lynch High Yield Bond Index. In the period from November 1984 through November 1993, all four variables had significant coefficients of the expected sign. Note that the coefficients on the two bond indices are of opposite sign, indicating a very strong response to relative returns between the two bond indices.

Mining equity returns were also significantly related to general stock market returns. It should be noted, however, that the regression coefficient arising out of the multiple regression is not the same as that arising out of the form of univariate regression used to calculate a conventional stock market beta as formulated in the Capital Asset Pricing Model. Over the same period, the CAPM betas for the individual precious metals funds ranged from -.29 to .42, with a median value of zero.

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### Multiple Regression Summary

Y = J&J PRECIOUS METALS AVE		Start:	8411	End:	9311
ANOVA	DF	SumSquare	MeanSquare		
Mean	1	64.09			
Regress	4	4052.78	1013.19		
Resid	104	2473.33	23.78		
F Ratio	42.60	StanErr	4.88	Multi R	.79
Prob(F)	.00	R^2	.62	Adj R^2	.61
D-W Stat	2.21				
		Estimate	StanErr	T-Stat	Pr(T)
A	INTERCEPT	.49			
X	GOLD: LONDON PM	1.48	.12	11.90	.00
X	S & P 500 COMPOS	.64	.13	5.04	.00
X	80/20 T-Bill/LBGTG	-2.96	.84	-3.53	.00
X	ML HY BOND	.87	.34	2.57	.01

The very substantial sensitivity to the "investor confidence" factor as proxied by changes in the bond quality yield spread (and related total returns), immediately suggests a clientele effect as an explanation for the low values of gold betas. It suggests that investors in gold stocks are themselves also likely to be investors in gold bullion. When investors lose confidence in the world economy, they switch out of gold stocks and into bullion. Gold prices rise and gold stock rise also, but at a far slower rate than would be expected, as the process of selling stocks to raise cash to buy bullion mutes the rise in stock prices. In times of expected prosperity, investors sell off the perceived "disaster insurance" of bullion for the spendable cash flow of gold stocks. Gold prices fall, but the switch to gold stocks cushions what otherwise would be a much more extreme fall for gold shares. With more than four billion ounces of gold estimated to be "above ground" at this time (3), the current aggregate value of bullion and jewelry gold is more than an order of magnitude greater than our estimate of the value of gold mining equities noted earlier. As such, only a very small portion of the world's gold investors need follow such a course in order to cause the observed behavior of gold mining equities relative to changes in gold prices.

To further clarify the influence of investor confidence on gold stock prices, the Northfield macroeconomic model was used. This model is based on Arbitrage Pricing Theory as first set forth by Ross, Roll and Chen (9). The model uses changes in seven macroeconomic variables to explain the prior sixty months' returns for all U.S. securities. One of the factors is investor confidence, as measured in this case by the spread in yield between high quality corporate bonds (AAA rated) and intermediate quality corporate bonds (Baa rated). When confidence is high, the yield spread narrows, while in times of uncertainty, investors require greater yield premiums to accept the risk of lower credit quality bonds. Using data through September 1993, an equally weighted portfolio of 34 widely traded gold stocks was constructed. The response to the investor confidence variable was statistically significant for almost all of the 34 individual stocks. Assuming that all other macroeconomic state variables remained constant, the expected response of this portfolio to a .3% (one standard deviation) increase in quality yield spread (investor confidence is dropping) is a loss of value of approximately 3% for the average gold mining stock relative to the bullion price.

As of the end of September 1993, the value of this bond quality yield spread was .52%, as compared to an average of .64% from January 1969 through September 1993. The monthly standard deviation of this value over the entire series is .40%, which is much larger than has been observed over the recent sixty month period.

As an interesting sidelight, a regression of changes in gold prices against the gold fund index returns lagged one month yields a positive coefficient of .21 ( $t=2.81$ ), suggesting that at least on a short-term basis, prices for gold related equities tend to lead bullion prices.

In conclusion, it seems clear that much of the relative performance of gold mining related equities as compared to bullion can be explained as the impact of investor confidence on investor decisions. In addition, it is clear that gold related equities are considered speculative by investors, and are favored in times of rising economic confidence, coincident with the relatively good performance of high yield bonds as compared to other fixed income securities. In addition, the price movements of gold mining equities are a persuasive leading indicator of short-term gold bullion price movements.

**References:**

1. Hotelling, H., The Economics of Exhaustible Resources, **Journal of Political Economy**, April 1939
2. Miller M. and C.W. Upton, A Test of Hotelling Valuation Principle, **Journal of Political Economy**, February 1985
3. McDonald J. and B. Solnik, Valuation and Strategy for Gold Stocks, **Journal of Portfolio Management**, Spring 1977
4. Pindyck R., Uncertainty and Exhaustible Resource Markets, **Journal of Political Economy**, December 1980
5. Brennan M. and E. Schwartz, Evaluating Natural Resource Investments, **Journal of Business**, v58(2), 1985
6. Sundaresan M., Equilibrium Valuation of Natural Resources, **Journal of Business**, 1985
7. Sharpe, W., Asset Allocation: Management Style and Performance Measurement, Darden School of Business, University of Virginia, 1991
8. Copyright J&J Financial, San Antonio, Texas. The index is an equal weighted average of the monthly total returns, net of fees, of all US mutual funds classified as investing in precious metals by Investment Company Data Incorporated, Des Moines, Iowa. The index begins at June 1968.
9. Chen N., Roll R., and S. Ross, Economic Forces and the Stock Market, **Journal of Business**, 1986, v59(3)
10. Bache, J.J, **World Gold Deposits**, 1987
11. **Gold Demand Trends**, World Gold Council, November 1993