VARIABLES EXPLAINING THE PRICE OF GOLD MINING STOCKS

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ABSTRACT

The purpose of this study is to examine the relationship between an index of gold mining stock prices and a variety of explanatory variables. A sample of 656 cases of week ending values of the gold mining stock index (GOX) was used as a proxy for the industry. Multiple linear regression was used to study the variables. Five independent variables were found with an adjusted R-squared of 0.557. The results of this study corroborate previous studies and offer new insights into gold mining stock determinants. The topic is very timely with gold prices hitting historic highs recently. **JEL classifications:** C32, G10

INTRODUCTION

Investors have shown a particular interest in the determinants of gold stock values because of the general belief that the stocks can be a good substitute for direct purchases of the commodity itself. Gold stocks are seen as a method of avoiding the large transactions cost associated with purchasing gold and as a means of hedging when speculating in the gold market. The commodity, gold, can be subject to volatile prices changes, the impact of which is often thought to be lessened by purchase of gold stocks rather than gold.

Additional interest comes from those who view gold stocks as a way to examine the risk management in the context of a relatively uncomplicated firm structure; i.e., gold firms are primarily producing a single product that is traded in sometimes volatile markets for which there is a great deal of public information. The purpose of this study is to examine the relationship between an index of gold mining stocks and various macroeconomic variables including gold prices. Given recent increases in the price of gold to record highs, the topic is very timely and should be of interest to the investment and business community. Further, the topic should have practical implications for both investors and managers of gold mining companies.

In this paper we will review previous studies of gold stock values with special attention given to both market and gold factors. We will then specify a model to explain variation in gold price stocks and test it empirically with week-ending data for the period January, 1998 to July, 2010. The findings of the

empirical analysis will be described and discussed. Finally, conclusions resulting from the analysis will be discussed.

LITERATURE REVIEW

A number of variables have been identified that may influence the value of gold stocks, but two are most common in previous studies. Those are 1) measures of the commodity prices (gold factor) and 2) measures of the larger market movements (market factor). These have been used frequently to explain price movements of gold stocks. The latter is included to control for gold stock price changes that result from general movements in the stock market. Other variables include measures of volatility (Twite, 2002), foreign exchange rates (Faff and Chan, 1998), interest rate returns (Faff and Chan, 1998), quantity of gold extracted in a given time period (Blose and Shieh, 1995), cash costs per time period (Blose and Shieh, 1995), proven reserves (Blose and Shieh, 1995) and a volatility measure of the responsiveness of total value of a firm's risk management portfolio to changes in gold price (Tufano, 1996 and 1998).

Previous studies have obtained gold stock price data in several forms. Blose and Shieh (1995), Faff and Chan (1998), Tufano (1998), and Twite (2002) looked at individual gold mining companies and Blose (1996) focused on gold mining mutual fund prices. Others used gold price indices. Twite (2002) employed the Australian Stock Exchange (ASX) gold accumulation index while Gilmore, et. al (2009) measured gold stock prices using the Chicago Board of Options Exchange (CBOE) Gold Index (GOX) and AMEX Gold BUGS Index. Gold prices have come primarily from the New York Commodity Exchange (COMEX) data published by Handy and Harman (Blose and Shieh, 1995; Blose, 1996; Tufano, 1998; Smith, 2001) and the London daily fixings (Smith, 2001; Gilmore, et. al 2009). Faff and Chan's (1998) study of the Australian market used the Australian Bureau of Statistics RBA database. Measures of broader market movements have included CRSP composite index (Blose and Shieh, 1995; Blose, 1996; Tufano, 1998; Smith, 2001); S & P 500 (Smith, 2001; Twite, 2002; Glimore, et. al 2009); and ASX All Ordinaries Index (Twite, 2002).

Most studies have found a relationship between gold prices and gold stock prices. Blose and Shieh (1995) studied 23 gold mining companies and found that the value of their stocks was influenced by the return on gold prices, cash costs, levels of gold reserves and the proportion of assets after accounting for market factors. Blose (1996) was able to estimate gold price elasticity with respect to gold mutual fund prices but found that over half of the price movements in 27 mutual funds studied are explained by factors other than gold prices. Faff and Chan (1998) found that only returns on gold and market factors had any explanatory effect on gold stock indices in Australia. They examined but found no evidence that foreign exchange rates and interest rates had an impact. Gilmore, et. al (2009),using cointegration analysis, found that the GOX index, gold prices, and large-cap S&P 500 had the same long-run stochastic trend.

Tufano (1998) calculated gold *betas* and market *betas* for 48 North American gold mining firms across different quarterly periods for each of the firms. The *betas* measured the exposure of gold mining stocks to changes in the price of gold and changes in the broader market. He found the average stock mining stock moves 2 percent for each 1 percent change in gold prices but that

exposures vary considerably over time and across firms. The variation in the gold firm exposures were found to be significantly related to the firm's hedging and diversification activities, to gold prices and gold return volatility.

Twite (2002) studied 12 gold mining companies in Australian and found that on average a 1.00 percent change in Austrian-dollar-denominated gold prices induced only a 0.76 percent change in the price of listed gold-mining stocks. One consequence of this is that discounted cash valuation methods underestimate the price of gold stocks. Twite (2002) sought to explain the gold premium, the proportional difference between gold firm's stock price and its value determined by the discounted cash flow valuation model. He found evidence that the gold premium is attributable to the existence of managerial flexibility or real options, the opportunities to invest in real assets under potentially favorable conditions at some future point in time; e.g., mining firms may suspend operations during periods of unfavorable gold prices and defer to period when prices are higher.

METHODOLOGY

A sample of week ending values of a gold mining index was used as a proxy for stock prices in the gold mining industry. The index (known as the GOX Index) is an equal-dollar weighted index composed of 12 companies involved primarily in gold mining and production. The GOX Index was created in 1994. The data in this paper cover a period that encompasses most of the history of the index.

The weekly closing interest rates for the 13-week Treasury bill, the 5 year Treasury note, the 10-year Treasury note, and the 30-year Treasury bond were used in the study. Two measures of the yield curve were computed – the ratio of the 10-year Treasury note yield to the 13-week Treasury bill yield and the ratio of the 10-year Treasury note yield to the 5-year Treasury note yield. These interest rate variables were included to capture bond market factors. Independent variables other than interest rate variables used in the study include the price of gold, the value of the U.S. dollar (as measured by the Finex spot index consisting of a basket of foreign currencies), the S&P500 stock index, the Commodity Research Bureau (CRB) index of commodity prices, the price of crude oil, and the VIX (a measure of stock market volatility).

Data were taken from January 1998 through July 2010. During this time period, there were both rising and falling stock markets. There were also periods of relatively high and low interest rates and periods of fluctuations in the price of the gold commodity and other variables. Therefore, the results should be robust to a variety of market trends. A total of 656 cases of weekly observations are included in the study.

One of the common problems associated with using time series economic data is that the series is often non-stationary. Since regression techniques require that data in a series be normally distributed, it is necessary to convert the non stationary series into a stationary one. We followed the standard methodology which is to first compute logarithms of each series. Then tests were run to determine the stationarity of each series using the Augmented Dickey Fuller test for a unit root. If a series has a unit root, the series can be made stationary by taking first differences of the data. It was found that each series was non stationary with a unit root. Therefore, first differences of the logs

of the raw data were computed and used for each variable in the regression analysis. Stepwise regression was then used to find the best set of variables to explain changes in gold mining stock prices.

The dependent variable was DLOGOX, the first differences of the logs of the GOX index. We anticipated a positive relationship with DLOGLD, first differences of the logs of the price of gold, since this was found in previous studies (Blose and Shreh, 1995; Blose, 1996; Faff and Chan, 1998; Gilmore, et. al., 2009). We also expected DLOGOX to have a positive relationship with DLGCRB, the first differences of the logs of the CRB Index, since commodity prices, in general, and gold vary in a similar fashion (Moss and Moss, 2007). Further, we expected a positive relationship with DLOGSP, the first differences of the SP500 stock index. Previous studies had found gold mining stocks to be positively related to broad measures of the stock market (Tufano, 1998; Faff and Chan, 1998; Gilmore, et. al., 2009). We expected a positive relationship with DLOGCR, first differences of the price of crude oil. Crude oil is another commodity which follows the price of other commodities in general (Moss, Moss, and Mayer, 2010). Finally, we expected a negative relationship with DLGDOL, first differences of the value of the U.S. dollar (Moss, 2004), i.e. falling values of the dollar would be related to rising gold prices, *ceteris paribus*.

FINDINGS

Table 1 shows the correlation coefficients for all variables in the final regression equation. Significant correlation between independent variables is evidence of multicollinearity . One way to detect multicollinearity among the independent variables is to check the correlations among the independent variables. A correlation coefficient of 0.70 or higher between any two independent variables is an indication of possible multicollinearity problems. However, the results in Table 1 show that the correlations are well below 0.70 and sufficiently low to initially rule out any multicollinearity among the independent variables included in the study. Furthermore, each the correlation coefficients between the individual independent variables and the dependent variable, DLOGLD, have the signs that were expected.

Table 1

Correlation Coefficients for the Variables Used in the Multiple Regression Equation

	DLOGLD	DLGCRB	DLOGSP	DLOGCR	DLGDOL
DLOGLD	1.0	.405**	-.007	.123**	-.396**
DLGCRB	.405**	1.0	.288**	.577**	-.382**
DLOGSP	-.007	.288**	1.0	.095*	-.042
DLOGCR	.123**	.577**	.095*	1.0	-.128**
DLGDOL	-.396**	-.382**	-.042	-.128**	1.0

Note: Number of observations used in the regression = 656.
** Correlation is significant at the .01 level.
* Correlation is significant at the .05 level.

Table 2 shows the results of the regression analysis of all independent variables on the dependent variable, DLGOX. All the independent variables were tested to find those that best explain the variation in gold mining stock prices. Stepwise regression was used to eliminate variables that do not explain the variation in the dependent variable. The process leaves only those independent variables in the equation which, as a group, best explain the variation in the dependent variable. The adjusted R-squared value of .557 indicates that the equation explains over half of the variation in gold stock prices. The Durbin Watson statistic of 2.250 indicates an absence of autocorrelation. All of the regression coefficients are significant at the .05 level of significance and three of the five are significant at the .01 level of significance. Further, each of the coefficients has the sign expected by the model. The price of gold variable, DLOGLD, is shown to be directly related to the price of gold stocks. Anticipated direct relationships to the CRB commodities index, crude oil prices, and broader market trends measured by changes in the S & P 500 were found. Finally, the inverse relationship between the value of the dollar and gold stock prices was as expected.

Table 2

Results of the Regression of the First Differences of the Logs of GOX on Various Economic Variables

Dependent	Variables	P-value
DLOGOX	Constant	
	0.000	0.375
	DLOGLD	
	1.386	0.000
	DLGCRB	
	0.240	0.020
	DLOGSP	
	0.264	0.000
	DLOGCR	
	0.098	0.002
	DLGDOL	
	-0.332	0.026

Note: Number of observations used in the regression = 656. Shown above are the unstandardized coefficients for the independent variables and the constant. Adjusted R-squared = 0.557 and Durbin Watson = 2.250.

To verify the results of Table 1 and to have a more direct test for multicollinearity, we consulted the VIF (variance inflation factor) and tolerance measures which detect multicollinearity among the independent variables. Table 3 shows the results of tests to compute these measures. Tolerance values below 0.10 or VIF values above 10 indicate the presence of multicollinearity. Because all the values in this table are no greater than 2.2, multicollinearity is not a problem in this equation.

Table 3		
Collinearity Statistics for Independent Variables Used in the Study		
	Tolerance	VIF
DLOGLD	0.746	1.340
DLGCRB	0.463	2.159
DLOGSP	0.874	1.144
DLOGCR	0.647	1.546
DLGDOL	0.762	1.312
Note: Tolerance values below 0.10 or VIF values above 10 indicate the presence of multicollinearity.		

CONCLUSIONS

Several of the results of the study support those of previous studies. Gold mining stocks are strongly and significantly sensitive to changes in both the price of gold and wider movements in the stock market. These are both widely reported findings that are confirmed by our research. One study (Faff and Chan, 1998) attempted to relate gold stock prices to foreign exchange rates and failed. Our study was able to identify a significant negative relationship between the value of the dollar and gold stock prices. In addition, we find significant positive relationships between gold stock prices and both oil prices and the overall level of commodity prices. We are aware of no comparable findings elsewhere in the literature.

Our results have practical implications for investors. Investors who believe that gold prices will be moving higher (lower) might do well to overweight (underweight) their portfolios with gold mining stocks. Gold mining company managers who believe that gold prices have peaked might find this to be a good time to issue new shares of common stock as a way of obtaining additional long-term financing. If they believe that gold prices have bottomed, they might do well to repurchase shares of their company's common stock if excess funds are available.

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