

Risk Management Determinants Affecting Firms' Values in the Gold Mining Industry: New Empirical Results

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Abstract

The goal of this article is to isolate the significant determinants that affect the decision of non-financial firms to hedge their risks. Our application is for the North American gold mining industry. The random variable considered is the selling price of an ounce of gold. We show that several factors related to maximizing the firm's value significantly affect the decision to hedge the price of gold. We also show how the tax-save variable proposed by Graham and Smith (1999) performs to explain the decision to hedge in this industry.

Keywords: Empirical measure, determinants, risk management, non-financial companies, Tobit, panel, mining companies, gold, tax-save.

JEL Classification: D80, G10.

1. INTRODUCTION

For more than 15 years, the finance literature has featured discussions about the theoretical determinants of risk management, but very little has been done to measure effectively the relevance of the various determinants proposed. Tufano (1996) identifies two classes of arguments used to show why non-financial firms might undertake risk-management activities: to maximize the firm's value and to protect risk-averse managers. These two classes of argument were developed in the principal theoretical studies on the subject (see the recent contributions of Stulz, 1996, Doherty, 2000, Froot, Scharfstein and Stein, 1993, Caillaud, Dionne and Julien, 2000, MacMinn and Gaven, 2000). The two main results of Tufano's study are that whereas the determinants proposed to maximize the firm's value have practically no significance; the determinants related to managers' risk behavior do.

The goal of this article is to determine what theoretical determinants are statistically significant in explaining how tightly non-financial firms manage risks, as applied to the North American mining industry. In a recent review article, J. Cliche (2000) offered a complete analysis of the principal studies on the empirical determinants of risk management in non-financial firms. Showing that very few of the determinants that do have an effect also have the right coefficient, this article comes to a noteworthy conclusion: the statistical data and methods used to measure the relevance of different

determinants do not always stand up to the authors' ambitions. It is, therefore, quite likely that the absence of significant findings on effects related to maximization of the firm's value may be better explained by inadequacies in the empirical studies published to date rather than by weaknesses in the theories advocating that firms take an integrated risk-management approach.

We share these conclusions. It is very difficult to obtain relevant data and to construct samples large enough to isolate statistically significant effects. The article published by Tufano (1996) offered a first attempt to improve the methodology. In this article, we propose to extend his analysis. We, consequently, updated the author's data base and recalculated the determinants affecting the firm's value. We employed a method that take explicitly into account the time-sensitive (or panel) aspect of the data and we applied the method to quarterly data in order to better fit the continuous decision process of the managers. We also used the methodology proposed by Graham and Smith (1999) to measure the effect of the tax incentive on hedging.

After reviewing the principal determinants influencing risk management decisions in non-financial firms, we give a brief description of our methodology and discuss our results. In closing, we sum up the main points of our study.

2. WHAT ARE THE MAIN DETERMINANTS AND HOW CAN THEY BE MEASURED?

Let us review the main theoretical determinants proposed to maximize the firm's value. We shall not give a detailed justification of each of the determinants, as they are well documented in the articles discussed. We choose rather to identify them and show how they can be measured to produce statistical findings. A more formal description of the variables used in the empirical analysis is given in the Appendix.

Leading into the nub of the matter, we will immediately point out that, in the companies studied, the main risk resides in the selling price of an ounce of gold. In other words, our study focuses on the way risks are managed by executives of mining companies whose main production is gold. We shall enter into a more detailed discussion of the hedging variable in the next section.

Four principal determinants are often cited in the literature to justify risk-management activities: 1) reducing the expected costs of financial distress; 2) reducing the risk premiums payable to various partners; 3) increasing investment possibilities; 4) reducing expected tax payments. As already mentioned, the articles by Stulz (1996) and by Froot et al. (1993) take a detailed look at the motivations behind these determinants. We here intend to show how those theoretical effects can be measured statistically.

Reducing the costs of financial distress and risk premiums to partners: These costs will be high mainly for firms with heavy debts. They will also be high for firms with risk-averse stakeholders. In the empirical studies consulted, these first two determinants are often grouped together, because there are no variables capable of distinguishing between them. The intuition of a positive effect on the firm's level of hedging resides in the following: firms with high expected financial-distress costs and those with high risk premiums to pay are more strongly motivated to hedge their risks in order to reduce these costs and increase the firm's net value.

Four variables are used to measure such costs. The average direct and indirect monetary production or operating costs (cash-costs) can be used based on the argument that firms with high production costs are less efficient; more prone to financial failure; and pay higher premiums to their partners. Interest costs and non-monetary costs, such as mortgages, are not included. The cost of producing an ounce of gold represents the mining company's short-term technology. If the price of gold falls below the average cost of production, the firm will find itself in financial difficulty, a more likely eventuality for inefficient firms.

Long-term debt weighted according to market value is the second variable used to measure the costs of financial distress. The previous variable is more closely related to the probability of financial distress, whereas this one has more to do with the costs resulting from financial distress, supposing that such costs are proportional to the face value of debt. We can thus predict a positive sign for these two variables in the case of firms whose capital structure calls for protection, meaning firms that use a lot of external financing. We also consider payment of dividends and the use of preferred shares to measure financing possibilities other than debt. A negative sign is predicted for these two variables.

Increasing investment possibilities: The leading argument here hinges on the reduction of fluctuations in internal earnings by hedging risks so as to minimize the need to seek external financing for investment projects, especially in the event of low internal earnings. It is well known that external financing is more costly because investors and entrepreneurs are in a situation of asymmetrical information regarding the quality of investment projects (Froot, Scharfstein, and Stein, 1993).

Thus, if we have a single random variable such as internal earnings, we should observe a positive relationship between investment opportunities and the hedging of risks. But this relationship can be very weak and even negative if the values of the investment opportunities are themselves random. To be specific, if the latter are also linked to the price of gold, natural diversification will occur within the firm and there will be much less need for hedging. For example, if the price of gold has a positive effect on both investment opportunities and the source of internal financing, then the two values will be positively correlated: they will be high when the firm needs to invest and low when there is no need to invest.

Two variables can be used to measure investment opportunities: exploration and acquisitions. Their predictive signs on risk management are undetermined or even negative under natural diversification. They will be positive otherwise. As for acquisition activities, we must distinguish between those within the industry and those external to the industry, the latter being interpreted as a substitute for the diversification of risks (Tufano, 1996).

The convex nature of taxes: With a convex tax structure, hedging to cover risks may cut average taxes by reducing fluctuations in earnings. The simplest argument is linked to governments' asymmetrical methods of taxation, which creates the desired convexity (see, for example, the discussion in Doherty, 2000 and Graham and Smith, 1999). But accounting for tax incentives is very complex and it is not obvious that the variables used by researchers are always the appropriate ones for measuring the convexity of the tax structure, which may explain the counter-intuitive empirical results sometimes obtained in the literature.

For Graham and Smith (1999), the different variables proposed to measure the convexity of taxes are not really suitable to this function. The empirical relevance of studies analyzing empirical relevance

are often limited, because their statistical strength is undermined by the small number of observations available. Their data show that tax functions are convex for only about 50% of the firms in their sample, whereas all researchers model convexity in the same way for all the firms in their sample. They have thus used different simulations and formulated an equation allowing other researchers to compute the taxes saved as a result of risk management. This computed tax save variable should have a positive effect on hedging. We applied their model to compute a tax save variable. We also used a different tax variable. This variable (deferred income tax) measures the inverse of the tax function's convexity. So a negative sign is predicted. A positive sign is predicted for the tax save variable derived from the Graham and Smith model.

Size of the firm: This control variable can be used as an indirect measure of financing costs. As a rule, the largest firms have greater negotiation power and thus lower average financing costs, which reduces the need to hedge risks. But this variable can also measure the accessibility of different methods of diversifying risks: qualified personnel, software, consulting fees. Most surveys show that it is the larger firms which tend to diversify, whereas it is the smaller ones that are in greatest need of such a strategy (Stulz, 1996). We should thus expect this variable to have an ambiguous sign.

Liquidity ratio: This variable measures the liquidity reserve for emergencies. A negative sign is predicted. It is worth noting that the risk management of firms' liquidity is an important risk-management activity.

Financial constraint: Finally, we may consider a financial-constraint variable as a substitute to both long-term debt and the liquidity ratio. A positive sign is predicted since firms with high financial constraint may use hedging to reduce the burden of that constraint.

3. CONSTRUCTION OF THE DEPENDENT VARIABLE

The dependent variable measures the percentage of gold production covered by risk-management activities. This is the Δ_t %, the fraction of gold production (at date t) whose price is covered for the remainder of the current year and the next two years.

Among the main transactions, we find, for example: forward sales of quantities of gold at a price fixed over a number of years; gold loans with reimbursements in ounces of gold over a number of years; holding of put options; and selling of call options on the market. These different quantities of ounces of gold whose price is covered by various sorts of contracts can be transformed into Delta ounces by using the financial theory of derivatives. The Delta is the slope of the curve linking the value of an underlying asset to that of a derivative product such as an option, but it may also be interpreted as the quantity in the underlying asset (short or long) needed to construct the replicating portfolio.

For loans payable in ounces of gold and for forward-sales contracts, the Delta is equal to -1, because there is no uncertainty that the transaction will occur; but, for options, Delta values must be computed using the Black and Scholes formula, which takes into account the probability that the option will be exercised. Finally, we can compute the firm's total Delta % by dividing the sum of ounces whose price is covered over the same period by the total estimated production over the remainder of the current year and the subsequent two calendar years.

Table 1 shows the distribution of the Delta % (quarterly) in the industry over the 8 years covered by our study (a possibility of 32 quarters by firm instead of 16 for Tufano). It should be noted that there are no negative net values, but that, in some quarters, certain values exceed 100%.

(Table 1, about here)

4. RESULTS

We now move on to our estimation of the determinants. The table in the Appendix describes the variables of the model.

Table 2 reports values of the variables used to compute the tax-save variable and shows the distribution of the tax-save values. The values reported are in the ranges of those of Graham and Smith for 5% reduction in volatility (Table III, page 2255). We observe that the mean of the tax save variable is about 5% while its standard derivation is equal to 3.3%.

As for Tufano (1996), we considered the delta-percentage as a censored variable, so we used the Tobit model. This procedure permits us to take into account discontinuities in the dependent variable. For example, a zero delta-percentage may mean that the firm never hedges or that the optimal hedging ratio is nil for a given quarter. It also takes into account the fact that, below a certain optimal percentage, the firm may decide not to hedge, so we observe a zero delta-percentage. In order to take into account of the serial correlation of the error terms, we applied the LIMDEP panel procedure, since we had a sufficiently large number of observations. As the results indicate in Table IV, the two sigma variables are significant. In particular, sigma (μ) indicates that we had to make a correction for temporal correlation. Finally, a standard test for the presence of heteroscedasticity rejects this possibility. Details will be provided upon request.

(Table 2, about here)

Table 3 presents our estimation results.

(Table 3, about here)

We observe several interesting results. The first two columns (A and B) report coefficients obtained with all the firms for which we have data, whereas the last two do so when the observations for Barrick Gold are removed.

Let us first interpret the coefficients in the first column (A). They indicate that seven variables linked to maximization of the firm's value have a significant effect ($P < 0.05$) on the decision to hedge. Firms with high unit-production costs, tight financial constraint, large tax-save possibilities, and large operations (reserves) are more likely to hedge their selling price, whereas those that defer income taxes, pay dividends, and use preferred shares for financing will be less likely to hedge their production costs. The coefficients of the two investment-opportunity variables are not significantly different from zero.

The second column (B) indicates that if we use the “liquidity ratio” and the “firm’s long-term debt” ratios as substitutes for the “financial-constraint” variable, the results remain unchanged. Moreover, the coefficients for both these variables have the right sign, meaning that firms with more debt hedge more and those with liquidity reserves have less need to hedge. Columns C and D indicate that few results are sensitive to the exclusion of Barrick Gold. To be specific, six variables remain significant (at the 10% level) in column C. But the “deferred-income-tax” variable is no longer significant. The same comment applies for the specification in column D.

5. CONCLUSION

These preliminary results clearly indicate that many determinants related to maximization of the firm's value are statistically significant. Particularly, variables related to tax and financial distress (or risk premia to stakeholders) are significant. However those related to investment opportunity had no effect, possibly because the natural hedging argument developed by Froot, Scharfstein, and Stein (1993) is applicable in this industry.

One criticism we can make about the literature on risk management in non-financial firms is that it is still far from adopting a portfolio approach making it possible to observe simultaneously all the firm’s possibilities for diversification of its overall portfolio (interest rates, foreign exchange rates, commodity prices). In other words, very few authors propose models capable of measuring potential correlation between the different sources of risks for firms and very few approach the different strategies simultaneously: purchase of insurance, hedging against currency exchange fluctuations, credit risk of partners... We could extend this study by looking at all the firm’s management activities and measuring the degree to which they are complementary and interchangeable.

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Table 1
Distribution of Delta % Values

Value	Number of observations	% of observations
Delta % = 0	152	16.9
0 < Delta % < 10 %	193	21.5
10 % ≤ Delta % < 20 %	154	17.1
20 % ≤ Delta % < 30 %	127	14.1
30 % ≤ Delta % < 60 %	178	19.8
60 % ≤ Delta % < 80 %	53	5.9
80 % ≤ Delta % < 100 %	22	2.4
Delta % ≥ 100 %	19	2.1
Total	898	100
Mean		24
Standard derivation		27

Table 2
Frequency of Tax Save (TS) and
Mean (Standard Derivation) of Explanatory Variables

Value	Number of observations	% of observations
TS < 0 %	27	3.01
0 ≤ TS < 1 %	0	0.00
1 ≤ TS < 2 %	12	1.34
2 ≤ TS < 3 %	165	18.37
3 ≤ TS < 4 %	97	10.80
4 ≤ TS < 5 %	153	17.04
5 ≤ TS < 6 %	140	15.59
6 ≤ TS < 7 %	74	8.24
7 ≤ TS < 8 %	101	11.25
8 ≤ TS < 9 %	78	8.69
9 ≤ TS < 10 %	32	3.56
TS ≥ 10 %	19	2.12
Total	898	100
Mean of TS	4.9	
Standard derivation	3.3	

Table 3
Tobit Panel Regressions

	All observations				Without Barrick Gold			
	A		B		C		D	
	Coef.	P(Z>z)	Coef.	P(Z>z)	Coef.	P(Z>z)	Coef.	P(Z>z)
Constant	-0.1771	0.003	-0.1624	0.0071	-0.2218	0.0000	-0.1986	0.0002
Tax								
Deferred tax/assets	-0.6314	0.0265	-0.6470	0.0382	-0.4040	0.1894	-0.4597	0.1212
Tax save	0.0118	0.0000	0.0129	0.0004	0.0089	0.0081	0.0086	0.0000
Financial distress								
LT debt/MV			0.3067	0.0000			0.3687	0.0000
Unit production cost	1.0658	0.0000	1.0851	0.0000	1.2498	0.0000	1.2703	0.0000
Financial constraint	0.0936	0.0000			0.1201	0.0000		
Dividend ratio	-4.8635	0.0000	-4.7762	0.0000	-1.8921	0.0616	-1.8597	0.0820
Preferred shares/MV	-1.2495	0.0001	-1.3903	0.0000	-0.5286	0.0701	-0.7521	0.0247
Size								
Reserves	0.1080	0.0000	0.1082	0.0000	0.0361	0.0413	0.0467	0.0306
Investment opportunity								
Acquisition/MV	-0.0640	0.8174	-0.0329	0.9119	-0.0312	0.9112	-0.0094	0.9713
Prospecting expenditures/MV	-0.3581	0.3481	-0.4936	0.2594	0.3779	0.4417	0.1447	0.7667
Substitute								
Liquidity ratio			-0.5043	0.0879			-0.6878	0.0072
Statistics								
Sigma (v)	0.2023	0.0000	0.2047	0.0000	0.2012	0.0000	0.2026	0.0000
Sigma (μ)	0.1699	0.0000	0.1624	0.0000	0.1626	0.0000	0.1533	0.0000
Number of observations	898		898		868		868	
Chi-square	522.32		516.33		421.53		433.79	
Value p of the regression	0.0000		0.0000		0.0000		0.0000	

Notes: The “unit-cost” and “reserves” variables have been divided by 1,000 and 10 respectively to fit our software. This operation obviously does not affect the results. However, the coefficients have to be transformed to obtain the true size of the effects. Barrick Gold is treated separately because its risk management policy differs from that of other firms.

Appendix
Definitions of Variables
(All dollar values are in US\$)

Delta %: The Delta is the variation in the value of the portfolio of derivative products for every \$1 variation in the price of gold; the aggregate value of the portfolio, calculated quarterly, is then divided by the firm's gold production over the same period. The Delta % measures the level of derivatives used, that is the degree to which risks are managed.

Cash-cost: Average cash-cost to produce an ounce of gold. The variable is repeated in the four quarters of each year, as it is only available on an annual basis. Production costs determine the firm's productivity; they capture the financial distress factor: when the price of gold decreases, less efficient firms may become unable to pay current expenses. A positive sign is predicted.

Market value (MV): The number of ordinary shares multiplied by their unit market value at the end of the quarter plus the number of preferred shares issued multiplied by their value at par plus the value of stated liabilities.

L-T debt/MV: The book value of the long-term debt divided by the firm's market value. Debt generates compulsory interest payments. If the firm is unable to make its interest payments, it will get into strong financial difficulties. This ratio therefore captures the financial distress factor. A positive sign is predicted.

Dividend ratio: The annual per-share dividend announced, divided by the share price at the end of the quarter. By announcing a dividend, the firm promises to pay said dividend in the future. This ratio can capture the matching of cash flows and the future disbursements. It can also be a good indicator of the firm's financial health. A negative relationship is thus expected.

Preferred shares/MV: The number of preferred shares issued, multiplied by the value at par and then divided by the firm's market value. The preferred share is also a substitute for debt. Since an increase in the total value of preferred shares will translate into a reduction in the ratio of indebtedness, a negative relationship is expected.

Exploration expenditures/MV: Exploration expenditures, divided by the firm's market value. The variable is repeated for the four quarters of each year, as it is available only on an annual basis. The variable captures the growth- opportunities factor to the extent that exploration efforts are profitable. A non-significant relationship is expected, since the correlation between investment opportunities and cash flows is positive in the gold mining industry, i.e. gold producers benefit from natural hedging.

Acquisition/MV: The value of acquisitions announced during the quarter and aimed at firms in the same sector, divided by market value. The variable captures the growth-opportunities factor. A non-significant relationship is presumed, since the correlation between investment opportunities and cash flow is positive in the gold mining industry, i.e. gold producers benefit from natural hedging.

Deferred income taxes/ASSETS: The "deferred income" item of the statement divided by total assets. Tax credits for losses reduce deferred income, thus the ratio measures the inverse of the tax function's convexity. In our computations, this variable was selected because it was available on a quarterly basis, unlike the tax-credits variable.

Tax save: The variable was constructed with the Graham & Smith (1999) equation (1). This variable measures the tax save expected for a 5% drop in the volatility of taxable income. The computation was based on annual data, so the variable is repeated for the four quarters of each year. The more convex the tax function, the greater the tax breaks. Statistics regarding this variable are reported in Table III. A positive sign is predicted.

Reserves: The firm's proven and probable gold reserves (in ounces) at year's end. The variable is repeated for the four quarters of each year, as it is only available on an annual basis. As for the "market-value" variable, it refers to theories related to lower average financing costs and to economies of scale for risk-management activities. The sign is indeterminate.

Liquidity ratio: Cash on hand, short-term investments, and client accounts, divided by short-term liabilities. Liquidities can act as a cushion for financial disasters. They are thus substitutes for risk management and a negative relationship is expected.

Financial constraint: Binary variable. It equals 1 when the "L-T debt/MV" and "Liquidity ratio" variables are respectively above and below the industry's median. Otherwise it is equal to 0. A firm with a lot of debt and a thin liquidity "cushion" is a firm operating within the limits of financial constraint. The variable captures the financial-distress factor. A positive sign is predicted.