CEO STOCK AND OPTION HOLDINGS AS A DETERMINANT OF OPTION HEDGING BY GOLD MINING FIRMS

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Abstract

This paper seeks primarily to analyze CEO holdings of stocks and options in their firm as a determinant of the decision to hedge and the intensity of hedging with option-like securities in the gold mining industry. The findings show that CEO holdings play an important role in the choice and intensity of the use of option-like hedging instruments. In addition, results also show that the intensity of option-like instrument use for hedging is diminished when the CEO is also the chairman of the board. This original finding provides additional insight into the decision making process in this context. Moreover, our results show that when non-hedgeable quantity risk and hedgeable price risk are highly correlated, gold mining firms resort to operational hedging strategies through their production flexibility. Consistent with previous studies, our findings reveal that firm liquidity and profitability are positively related to both the use option-like instruments and the intensity of such use while cost structure and debt are positively related to use intensity. But contrary to previous findings, our results show that company sales are negatively related to the intensity of using option-like hedging instruments and investment opportunities are negatively related to the intensity of such use. Finally, investment opportunities as well as the high correlation between production levels and gold prices seem to have a negative impact on the decision to use option-like hedging in the gold mining industry. Several studies have focussed on the theoretical and empirical motives of hedging financial risks with derivative products by business firms. However, relatively few studies have examined the determinants of the specific choices that firms make in order to build an optimal portfolio of these instruments, or the level of risk coverage that they achieve by using them. The issue has gained in importance recently with the increasing use of derivatives for hedging purposes under the growing impulse of globalisation and of the higher volatility of commodity and financial prices. In the same vein, the development of new types of structured products that fit the specific needs of corporate and other users, and of more sophisticated models to value them, has provided firms with a greater range of instruments to choose from and has given even more relevance to the study of the determinants of that choice. To be sure, notwithstanding their apparent differences, derivative products could be grouped according to the symmetry of their payoff vectors into non-linear, option-like, instruments and linear instruments. This paper seeks to shed light on the choice that hedging firms make in this regard by analyzing the impact of CEO holdings of stocks and options in their firm on the decision to hedge with option-like instruments. The study uses a sample of firms in the gold production industry for the period 2002-2004. By focussing on a single industry the analysis is conducted within the context of a homogeneous source of risk for all the firms concerned, namely gold price fluctuations. More specifically, the study will focus on the factors affecting the choice of the hedging instrument on the one hand and on the level of risk coverage with that instrument on the other in the context of the sample under study. The paper is organised as follows: section I provides a review of the literature on the choice between linear and non-linear, option-like, instruments for hedging financial risks. The methodology and data of the study are described in section II and the empirical results are analyzed in section III. Concluding comments are presented in section IV.

Keywords: corporate governance, CEO holdings, gold mining firms

I.   Introduction

As mentioned earlier, the distinction between linear and non-linear, option-like, hedging instruments can

be done on the basis of the symmetry of their payoff vectors from the hedger's point of view. In this sense, Black (1976), Moriarty, Philips and Tosini (1981) and Culp (2004) consider futures and forwards as linear

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instruments that can be used to transfer the hedger's risks and hence reduce the volatility of his cash flows at a lower cost than option-like type instruments which are non-linear and can therefore be used as risk-limiting as well as income generating vehicles.

As regards the choice of particular instruments, Brown and Toft (2002) argue that in the presence of hedgeable and non-hedgeable risks, non-linear instruments are preferable to linear instruments. In the same vein, Gay, Nam and Turac (2003) contend that, in this context, the exclusive reliance on linear instruments increases the probability of over hedging and its related costs[1]. To avoid this problem the authors argue that the position in linear instruments must be reduced and replaced by non-linear instruments to hedge price risk. The degree of substitution between the two types of derivatives depends on the sign and value of the correlation coefficient between prices and quantities. Then by studying a sample of 671 non-financial firms for the period 1992-1996 the authors find that, as expected, the use of non-linear instruments is positively correlated with operating income risk (a non-hedgeable risk) whereas the use of linear instruments is negatively related to it. Similarly, Detemple and Adler (1988) argue that in the context of portfolio management, investors who face borrowing constraints or high price volatility should use non-linear instruments. Tufano (1996) however finds no significant empirical result that confirms this argument.

Moshini and Lapan (1992) argue that firms that are characterized by risk aversion and a flexible production schedule[2] should resort to non-linear instruments in order to optimize their hedging portfolio. On the other hand, Froot, Scharfstein and Stein (1993) contend that when cash flows and investment opportunities exhibit the same sensitivity to hedgeable risks, linear instruments can maximize the value added by the hedging activity. However, if these two sensitivities are different the maximization of the value added through hedging requires the use of non-linear instruments. Adam (2004) verified the arguments of both studies using a sample of 118 gold producing companies for the period 1989-1998. His findings however support only the arguments of Froot, Scharfstein and Stein.

Following Froot, Scharfistein and Stein (1993), Mello and Parsons (2000) and Adam (2002) show that when external funds are less expensive than internal funds[3], the hedging portfolio should mainly include long puts in order to generate additional payoffs only

in those states of the world where the firm is facing a deficit. However, if external funds are more expensive than internal funds, the hedging portfolio should include mainly short calls to substitute for the use of debt. Finally, if the costs of internal and external funds are similar, the portfolio should contain collars. Furthermore, Adam also shows that firms that have a low debt ratio, that do not have investment opportunities and that are exposed to a low level of non-hedgeable risk are more likely to use linear instruments.

From a different perspective, Thornton, Kim and Nam (2005) investigated the relationship between administrators' preference for linear or non-linear derivatives and the presence of call options in their compensation package. They find a positive and significant relationship between the number of call options owned by administrators and the use of non-linear instruments. These findings confirm those reported by Tuffano (1996) for gold producing firms.

II. Data and Methodology

The dataset for this study is made up of 315 firm-quarters in the gold mining sector. The choice of sample length and frequency is based on data availability and was made to insure adequate representation of the problem to be analyzed. As mentioned in previous studies such as those of Tuffano (1996), Dionne and Garand (2003), Savor (2004), Dionne and Triki (2004), the gold mining sector provides an interesting opportunity for risk management studies. Firms in this sector are exposed to a common source of risk, fluctuating gold prices, for which a wide variety of hedging instruments is available. In addition, the details of gold mining firms' diverse risk management strategies are often readily available in their financial statements. These statements are used in our study to supplement data obtained from the Gold Hedging Indicator publications for the period 2002-2004. The resulting dataset is thus comprised of quarterly observations for 38 different gold mining firms that have used some form of hedging strategy between the first quarter of 2002 and the last of 2004. In total 29.0% of the firms that used some form of hedging did not use any options throughout the sample period, 52.6% used options in combination with other hedging instruments, while 18.4% used only options to hedge their exposure to gold price fluctuations. It should be noted that this dataset is limited to firms that show non-zero levels of risk management. The empirical results that will follow should therefore be interpreted as pertaining to the use of option-like instruments by firms that actively manage their exposure to risk.

Two models will be used to analyse the determinants of option use in risk management portfolios. The first model uses a PROBIT specification to estimate how a set of determinants based on the existing literature affect the probability of using option-like hedging instruments given that

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[1] Overhedging costs occur when production falls bellow the quantity sold by the futures contract and at the same time prices increase.

[2] Production flexibility is defined as the possibility to modify certain production parameters when market prices change.

[3] The author calls the difference between the costs of internal and external financing as *"credit risk premium"*.

the firm actively hedges its exposure to gold price fluctuations. In equation (1) tje determinants used in the model are grouped according to the strands in the literature reviewed in the previous section. The dependent variable (Option indicator) is equal to 1 when the firm uses option-like hedging instruments in a specific quarter and zero if only non-option-like instruments are used in the quarter. More specifically the model is defined as follows:

$$Option\ indicator = \beta_0 + \beta_1\ CEO\_SHARES + \beta_2\ CEO\_OPTIONS + \beta_3\ CHAIR + \beta_4\ Q\_VARIABILITY + \beta_5\ Q\_CORRELATION + \beta_6\ VOLATILITY + \beta_7\ M\&A + \beta_8\ EXPLORATION + \beta_9\ TANGIBLE + \beta_{10}\ OPORTUNITY + \beta_{11}\ CASH\_COST + \beta_{12}\ LN\_SALES + \beta_{13}\ LT\_DEBT + \beta_{14}\ D/E + \beta_{15}\ CASH + \beta_{16}\ PROFITABILITY + \varepsilon \qquad (1)$$

Where
CEO_SHARES is the market value of the CEO's company shares;
CEO_OPTIONS is the number of company options held by the CEO;
CHAIR is an indicator variable equal to 1 if the CEO is also the chairman of the board and zero otherwise;
Q_VARIABILITY is the standard deviation of the percentage change in quarterly production quantities;
Q_CORRELATION is the correlation between production levels and gold prices;
VOLATILITY is the standard deviation of gold prices for the 8 previous quarters;
M&A is the ratio of acquisition expense to tangible assets;
EXPLORATION is the ratio of total exploration costs to total assets;
TANGIBLE is the ratio of tangible assets to total assets;
OPPORTUNITY is equal to (book value of the firm – the book value of equity + the market value of equity) divided by the book value of total assets;
CASH_COST is the firm's cash production cost per once of gold;
LN_SALES is the natural logarithm of the firms quarterly sales;
LT_DEBT is the long term debt ratio;
D/E is the debt to equity ratio;
CASH is the ratio of cash and cash-like securities to total short term assets;
PROFITABILTY is the ratio of the difference between the gold spot price and the firm's cash cost to the firms cash cost.

The second model seeks to determine the degree to which firms use option-like instruments in proportion to their overall hedge portfolio. Given that this proportion is censored at 0, a TOBIT specification is used to estimate the model. More specifically, the degree to which firms use option-like instruments in their hedging strategy is computed using a variation of the delta% measure proposed in Tuffano (1996). That measure is essentially the adjusted level of hedged production for the next three years scaled by the firms anticipated production over the same period. The adjustment introduced in this paper uses an estimate of the sensitivity of the various financial instruments in the firm's risk management portfolio to small changes of the underlying security, in this case, gold. Hedged production levels are therefore weighted by the sensitivity of the specific contracts used by the firm. By contrast, the measure proposed by Tuffano (1996) represents the sensitivity of the overall hedge portfolio to small variation in the gold price and can be estimated using the sensitivity and weight of each individual component of the risk management portfolio. In our study, the relative importance of option-like instruments is computed by dividing this measure for the option-like instruments in the hedge portfolio by the firm's measure of the overall risk management strategy including all hedge instruments. Alternatively, the measure represents the proportion of the firm's production hedged using option-like instruments divided by the proportion of the firm's production hedged using all instruments.

The average proportion of option-like instruments in the hedge portfolio is 38.6% with a standard deviation as high as 42.5%. This variability remains an important part of this study and is analyzed using a TOBIT specification of a variation of model (1) where the dependent variable is the proportion of option-like instruments in the firm's risk management portfolio as follows:

$$\%OPTION = \beta_0 + \beta_1\ CEO\_SHARES + \beta_2\ CEO\_OPTIONS + \beta_3\ CHAIR + \beta_4\ Q\_VARIABILITY + \beta_5\ Q\_CORRELATION + \beta_6\ VOLATILITY + \beta_7\ M\&A + \beta_8\ EXPLORATION + \beta_9\ TANGIBLE + \beta_{10}\ OPORTUNITY + \beta_{11}\ CASH\_COST + \beta_{12}\ LN\_SALES + \beta_{13}\ LT\_DEBT + \beta_{14}\ D/E + \beta_{15}\ CASH + \beta_{16}\ PROFITABILITY + \varepsilon \qquad (2)$$

Dionne and Triki (2004), argue that manager risk aversion and the sensitivity of their personal wealth to company variability may affect their risk management decisions. The authors suggest that the greater the managers' aversion to risk, and the larger the fraction of their portfolios invested in their company's securities, the more likely they are to hedge firm risk even if such hedging may not always be optimal for the firm's shareholders. Smith and Stulz (1985) also show that when managers hold a large portfolio of shares in their company, they are more likely to hedge at the firm level to the extent that such hedging is less costly than if they had hedged their portfolio themselves. The authors also show that option holdings by managers are inversely related to company hedging and may actually provide managers with an incentive to increase company variability. In order to integrate such effects, our study focuses on CEOs holdings of their company's securities. More specifically, the market value of the CEO's company shares (CEO_SHARES) as well as the number of the company's options (CEO_Options) he holds is used to

measure the sensitivity of the CEO's portfolio to fluctuations in company value. The market value of the CEO's shares (CEO_SHARES) is measured by multiplying the number of shares declared in quarterly statements by the closing price at the last day of each quarter. In this regard, the preliminary analysis of our dataset shows that the CEO's holdings in our sample vary greatly. Indeed, the average market value of company shares held by CEOs is just over 3.5$ million and ranges from 0 to over 104$ million with a standard deviation of over 12$ million. On the other hand, the average number of options they hold is just under 1.2 million with a standard deviation of almost 1.5 million options. To further strengthen this aspect of our study, we introduce a variable to indicate if the CEO is also chairman of the board (CHAIR) in order to assess his influence over the firm's hedging decisions. Preliminary results show that this situation exists in 23% of the overall sample.

Although the price of gold can be hedged, gold mining firms remain exposed to production risks. More specifically, the risk associated with gold production quantities cannot be hedged using conventional financial instruments. To measure the impact of such unhedgeable risk, our study incorporates the impact of the standard deviation of percentage changes in quarterly production quantities (Q_VARIABILITY). Given that greater production variability will lead to additional uncertainty, this variable is expected to be positively related to the use of options as a hedging vehicle. On the other hand, given that firms can adjust production quantities according to gold prices, production flexibility may provide a natural hedge. To take account of these factors, the correlation (Q_CORRELATION) between production levels and gold prices is also included in the model and is expected to be negatively related to option use. Again, a great deal of variability can be observed in this regard in our dataset. Indeed, production variability ranges from 0% to a maximum of 576% while its correlation coefficient ranges from -96.3% to 99.0%. The overall market volatility (VOLATILITY), which is expected to be negatively related to the use of option-like instruments given the positive relationship between option prices and the underlying volatility, is also included in the analysis. The measure is estimated by computing the standard deviation of gold prices for the last 8 quarters.

The possibility of financial distress is captured in our model through several measures all of which are expected to have a positive relationship with option use in risk management portfolios. First, the firm's cash cost of production per once of gold (CASH_COST), which provides a measure of the firm's cost structure, is included in the model to reflect its exposure to the risk of operational costs. Second, the natural logarithm of sales (LN_SALES) is added as a surrogate for the firm's size and its sensitivity to market fluctuations. Finally, the long term debt ratio (LT_DEBT) and debt to equity (D/E)

ratio are also used to measure the firm's financial risk exposure.

Froot, Scharstein and Stein (1993), and Adam (2003) show that if the firm's capital investment level relatively low (high), the likelihood of using options in its risk management strategy is decreased (increased). Consequently, our model integrates three measures of the firm's investment program, namely: external acquisitions (M&A), which are assessed using a ratio of the firm's acquisition expenses divided by the book value of tangible assets, total exploration costs divided by total assets (EXPLORATION), and the value of tangible assets divided by total assets (TANGIBLE). In addition, Huang (2003) argues that firms with greater investment opportunities are more likely to see their market value appreciate. To safeguard their market value appreciation potential, these firms are more likely to hedge with option-like instruments where the payoff vector is not limited on the upside. This consideration is included in our model through a measure of the firm's market value relative to its book value (OPPORTUNITY). More specifically, the measure divides the total book value of assets minus the book value of equity plus the market value of equity by the total book value of total assets.

Stulz (1996) shows that firms in good financial health may not need to hedge as much as others. Alternatively, greater financial health, all other factors constant, may allow the firm to better support the premiums associated with option hedging. To the extent that financial health is related to the firm's financial constraints as measured by the variables discussed in the previous section, firms with more liquidity and/or greater profitability should be more likely to use option-like hedging instruments. The model integrates this possibility by including a measure of liquidity computed by dividing cash and cash-like securities by total short term assets (CASH). In addition, the profitability effect is analysed using Adam's (2004) measure whereby the difference between the gold spot price and the firm's cash cost is divided by the firms cash cost(PROFITABILITY).

III. Empirical Results

The empirical analysis begins with an examination of gold mining firms' likelihood of using option-like instruments in their risk management portfolio. To conduct this analysis, the model in equation (1) is estimated using a PROBIT specification where the dependent variable is an indicator of whether or not the firms have used options in a given quarter. The impact of the specified determinants is then assessed in an effort to determine the drivers of option-like instruments use. The analysis then proceeds to examine the proportion of option-like hedging instruments used with respect to the overall risk management portfolio. To this end, the model in equation (2) is estimated using a TOBIT specification

where the dependent variable is the extent of option use.

In what follows we discuss the results of the analysis first in terms of the likelihood of using option-like risk management instruments, as presented in table 3.1, and then in terms of the intensity of such use given that the firm has decided to use a non-zero level of risk management using financial instruments, as presented in table 3.2.

Tables 3.1 and 3.2 here

CEO Impact

Consistent with expectations, the CEO stock and options holdings in the firm are related to the firm's use of options in a statistically significant manner. Previous studies have shown that the propensity to hedge and the extent of company hedging are positively related to management share holdings and inversely related to their options holdings. Our findings add an interesting dimension by showing that in the event that firms decide to hedge their risk, the likelihood of including options in the company portfolio is positively related to both the value of CEO shares in the firm and to the number of options he/she holds.

In this regard, previous results, such as those of Smith and Stulz (1985), Tufano (1996) and Dionne and Triki (2004) have shown that, generally speaking, when managers hold options in their firm they are less likely to hedge its risk. The literature also shows that the more the CEO's compensation package includes options the less he / she will resort to the use of risk management instruments in general, since the value of such options is a positive function of the firm's volatility. However, in this context, our results, presented in table 3.2, show that when risk management instruments are used, the extent of option use in the company hedging portfolio is positively related to CEO option holdings. Indeed, when the firm hedges its price risk, option-like hedging instruments allow managers to benefit from potential increases in gold prices while limiting the impact of potential decreases of personal holdings. The non-linearity of the risk management portfolio of the firm thus mirrors that of the CEO's compensation package. Furthermore it is also interesting to note that the extent of option use is negatively related to the CHAIR variable. More specifically, the results show that when the CEO is also the chair of the board, the firm is less likely to use options in its portfolio. Correlation results also indicate that the CHAIR variable is reasonably independent of the level of stock holdings of the Chair-CEO in the firm. Thornton, Kim and Nam (2005) argue that option use in company risk management is conditioned be the CEO's utility function. Our contention is that in view of his / her increased personal liability to shareholders and employees combined with the increased concern with financial markets' reaction to his / her policies,

the CEO-Chair's interests may be better served by a smoother progress of the firm's cash flow, which is more consistent with linear rather than non-linear risk management instruments.

Production risk

The results of the PROBIT analysis also show that, as expected, option use is negatively related to the firm's production flexibility. More specifically, table 3.1 provides evidence that the correlation between the firm's production levels and gold prices has a negative impact on its option use. Adam (2004) argues that production flexibility stems from the real options embedded in the firms' operating strategy. These imbedded options may lead to non-linearity in the firm's production function that can easily be made to match non-linear payoffs such as those of option-like hedging instruments. Hence, the negative relationship between production flexibility and the use of options by the firm is not surprising and provides further support for Adam's (2004) results. In the same vein, Gay, Nam and Turac (2003) also show that firms are less likely to use options when their production activity can be adapted to the fluctuations in their prices. Although the positive sign of the quantity risk relationship is consistent with these previous studies, we do not find the relationship to be statistically significant.

Investment opportunities

Table 3.1 also shows that for the period under study, the use of options by gold mining firms is negatively related to the firm's level of external investments through acquisitions and to its investment opportunities as measured by the market to book ratio. These results suggest that firms that invest more in acquisitions and have more investment opportunities are less likely to use options in their hedging portfolio.

Other results show that the firm's investment strategy also affects the extent of its options use. Consistent with the results pertaining to option utilization, the level of company external investment through acquisitions appears to be negatively related to the level of option use. Table 3.2 also shows that the firm's internal investments in exploration are also negatively related to its option use. A possible explanation could be that as gold mining firms require more internal funds for their investment may be less willing to allocate liquidity towards option premium thus preferring non-linear risk management instruments.

Financial constraints

Interestingly, our findings do not provide evidence of a relationship between option use and the measures of financial constraints. The firm's cash cost structure, size and debt levels are not found to be related to its

option use in a statistically significant manner. Bodnar, Hayt, and Marston (1998) report that firms that hedge with instruments other than option-like securities do so, among other reasons, to avoid the initial costs of option premiums. This contention may be further supported by this study's finding of a positive relationship between option use and both the firm's liquidity and its profitability. Firms with more liquidity and greater profitability may be in a better position to support option premiums. It should, however, be noted that liquidity may provide a substitute vehicle for hedging. Indeed firms with greater liquidity/profitability may be in a better position to absorb potential downfalls and thus may be less likely to hedge, in general. This study provides evidence supporting the fact that, if a firm hedges at all, it is more likely to use options the better its liquidity and profitability.

Consistent with previous studies, table 3.2 shows that both liquidity and profitability are positively related to the level of option use by the firm. This result provides further evidence that option hedging is associated with the firm's capacity to disburse the initial premiums of option-like securities. Interestingly, table 3.2 shows that, for gold mining firms that engaged in risk management between 2002 and 2004, the extent of option use is negatively related to firm size as measured by the natural logarithm of sales. In addition, both the firm's cash cost of production and debt ratio are positively related to the level of option use. It could be argued that smaller firms with more expensive operating cost structures and more debt may be more financially constrained than their larger counterparts irrespective of their short term liquidity position. In this case, our findings appear to be consistent with those of Detemple and Adler (1988) who argue that the extent of option use is positively related to the likelihood of financial constraints. A potential problem with the result that relates debt levels to risk management is that debt, as argued in Dionne and Triki (2004), may not be exogenous to the model. Since risk management affects the firm's risk characteristics and consequently its ability to support debt, hedging decisions may not be fully independent of its financial structure. However, to the extent that model (2) standardizes the level of option hedging by the level of overall risk management, the approach may at least partially control for potential endogeneity by measuring the extent of option use in proportion to the extent of overall risk management.

IV. CONCLUSION

This paper seeks primarily to identify the determinants of hedging with option-like securities in the gold mining industry. This industry offers several interesting characteristics that make it an ideal candidate for risk management research. Indeed, the gold mining firms are exposed to a common source of price risk – fluctuating gold prices – for which a great variety of hedging instruments are readily available. This situation has led to a wide range of observable risk management strategies within the industry. This study focuses, more specifically, on the determinants of the choice of option-like hedging strategies observed within a representative sample of North American gold mining firms that have used some form of risk management securities during the period 2002-2004. The study analyses two aspects of the use of non-linear hedging instrument. First, a PROBIT specification looks at the determinants of decision to use non-linear hedging instruments given the existence of some form of risk hedging with financial instruments. Secondly, the intensity of option-like instrument use is analysed using a TOBIT specification to account for the dependent variable being censured at zero.

The first main result shows that CEO holdings of company stocks and options play an important role in the choice and intensity of the use of option-like hedging instruments in the gold mining industry. Indeed, our study shows that both decisions have a significant positive relationship with the value of CEO stocks and number of option held in the company. This result is consistent with previous findings of the relationship between risk management in the firm and managerial holdings of its securities, in general. However, when the CEO is also chairman of the board, the intensity of using option-like hedging instruments is diminished relative to when the CEO does not cumulate both positions. This original finding provides additional insight into the decision making process in this context and reflects the fact that the Chairman-CEO may be more concerned with his ∕ her personal responsibility to shareholders and employees as well as with the market reaction to his ∕ her policies, which are better served by linear risk management instruments. Another important result shows that liquidity and profitability are positively related to both the decision to use option like hedging instruments and the intensity of such use even though the relationship with profitability is somewhat weaker. This finding supports previous work that shows that option use increases when the firm is less subject to financial constraints.

Other interesting results indicate that when the correlation between production levels and gold prices- the primary source of price risk – is high the likelihood of using non-linear hedging instruments is low. This finding indicates that when non-hedgeable quantity risk and hedgeable price risk are highly correlated; gold mining firms can resort to operational hedging strategies made possible by their production's flexibility. Moreover, contrary to previous findings for non-financial firms, our results show that for gold mining firms, company sales are strongly negatively related to the intensity of non-linear hedging instruments utilization. A possible explanation for this result could be that larger firms have a potentially better access external financing and are more likely to

have diversified operations which may reduce their need for hedging with non-linear instruments. On the other hand, this intensity of using non-linear hedging instruments is positively related to the firm's cost structure and debt although the relationship is weak. This last result is consistent with the financial literature that shows a positive relationship between operational and financial risk and the firm's propensity to hedge.

With regard to the firms' investment strategy, our results show that, contrary to expectations, the firms level of external investments, as measured by its acquisitions, is negatively related to both the firm's non-linear hedging use and the intensity of such use. Results also show that its exploration costs - a measure of internal investment - are negatively related to the proportion of option-like hedging securities in the risk management portfolio. In addition, contrary to previous results relating to non-financial firms, our results show that in the gold mining industry, investment opportunities are negatively related to the decision to use options to hedge the price risk of gold.

In sum, by focussing on a single industry, our study was able to abstract from differences in the sources of risk and their impact on hedging decisions. Furthermore, the availability of information on the hedging strategies of the firms in this industry makes for an interesting venue for risk management research. As other industries make their risk management practices more readily available, future research may extend the study's results to other contexts with homogenous sources of risk and asses how firms characteristics affect their hedging portfolio composition.

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Appendices

Table 3.1. The decision to use options

This table provides results for model (1) where a PROBIT model is used to estimate the impact on the decision to use options by firms that actively manage their risk. The dependent variable is equal to 1 is the firm use options is its risk management portfolio and zero otherwise. The model regressors include *CEO_SHARES,* the market value of the CEO's company shares, *CEO_OPTIONS,* the number of options held by the CEO, *CHAIR,* an indicator variable equal to 1 is the CEO is also the chairman of the board and zero otherwise, *Q_VARIABILITY,* the standard deviation of the percentage change in quarterly production quantities, *Q_CORRELATION,* the correlation between production levels and gold prices, *CASH_COST,* the firm's cash production cost per once of gold, *LN_SALES,* the natural logarithm of the firms quarterly sales, *LT_DEBT,* the long term debt ratio, *D/E,* is the debt to equity ratio, *M&A,* the acquisition expense divided by tangible assets, *EXPLORATION,* the total exploration costs divided by total assets, *TANGIBLE,* the tangible assets divided by the total assets, *CASH,* is the ratio of cash and cash-like securities to total short term assets, *PROFITABILTY,* is the ratio of the difference between the gold spot price and the firm's cash cost to the firms cash cost, *VOLATILITY,* the standard deviation of gold prices for the 8 previous quarters, and *OPPORTUNITY,* the book value of debt + the market value of shares divided by the book value of total assets.

Variables	Estimated coefficient	t-Statistic	P-Value
CEO_SHARES	$6,71^{E}$-04	4,6800	0,000***
CEO_OPTIONS	$9,24^{E}$-07	3,9700	0,000***
CHAIR	-0,1599	-0,3500	0,726
Q_VARIABILITY	0,0711	0,1900	0,849
Q_CORRELATION	-0,5489	-2,1200	0,034**
CASH-COST	0,0040	1,5800	0,113
LN_SALES	0,1362	1,1600	0,244
LT_DEBT	0,1891	1,2200	0,223
D/E	-1,9765	-1,1400	0,253
M&A	-8,8446	-2,5400	0,011**
EXPLORATION	3,3035	0,5100	0,608
TANGIBLE	0,0769	0,0500	0,962
CASH	0,0070	4,0700	0,000***
PROFITABILITY	0,0969	1,8400	0,065*
VOLATILITY	-0,0167	-0,9300	0,351
OPPORTUNITY	-0,8502	-3,6300	0,000***
Constant	-1,9247	-1,2900	0,199
Number of observations			178
Log Likelihood			-65,83
Pseudo R^2			0,4567
Prob > Chi 2			0,00

***   statistically significant at a 1% level
**   statistically significant at a 5 % level
*   statistically significant at a 10% level

Table 3.2. The extent of option use

This table provides results for model (2) where a TOBIT model is used to estimate the impact on the extent of options use by firms that actively manage their risk. The dependent variable is the proportion of options in the firm's risk management portfolio as a percentage of their overall coverage. The model regressors include *CEO_SHARES,* the market value of the CEO's company shares, *CEO_OPTIONS,* the number of options held by the CEO, *CHAIR,* an indicator variable equal to 1 is the CEO is also the chairman of the board and zero otherwise, *Q_VARIABILITY,* the standard deviation of the percentage change in quarterly production quantities, *Q_CORRELATION,* the correlation between production levels and gold prices, *CASH_COST,* the firm's cash production cost per once of gold, *LN_SALES,* the natural logarithm of the firms quarterly sales, *LT_DEBT,* the long term debt ratio, *D/E,* is the debt to equity ratio, *M&A,* the acquisition expense divided by tangible assets, *EXPLORATION,* the total exploration costs divided by total assets, *TANGIBLE,* the tangible assets divided by the total assets, *CASH,* is the ratio of cash and cash-like securities to total short term assets, *PROFITABILTY,* is the ratio of the difference between the gold spot price and the firm's cash cost to the firms cash cost, *VOLATILITY,* the standard deviation of gold prices for the 8 previous quarters, and *OPPORTUNITY,* the book value of debt + the market value of shares divided by the book value of total assets.

Variables	Estimated coefficient	t-Statistic	P-Value
CEO_SHARES	$1{,}01^{E}\text{-}05$	4,1000	0,000***
CEO_OPTIONS	$1{,}80^{E}\text{-}07$	5,7200	0,000***
CHAIR	-0,1539	-2,4800	0,014**
Q_VARIABILITY	-0,0062	-0,1800	0,858
Q_CORRELATION	0,0156	0,3800	0,702
CASH-COST	0,0005	1,7900	0,076*
LN_SALES	-0,0761	-4,2200	0,000***
LT_DEBT	0,5119	1,9000	0,059*
D/E	0,0089	0,5400	0,589
M&A	-1,1134	-2,1000	0,037**
EXPLORATION	-0,5173	-1,7600	0,080*
TANGIBLE	-0,2338	-1,0600	0,291
CASH	0,0011	8,3800	0,000***
PROFITABILITY	0,0114	1,9100	0,058*
VOLATILITY	0,0029	1,0200	0,308
OPPORTUNITY	0,0003	0,0100	0,993
Constant	0,1653	0,8100	0,419
Number of observations			174
Log Likelihood			-8,68
Pseudo R^2			0,89
Prob > Chi 2			0,00

***   statistically significant at a 1% level

**   statistically significant at a 5 % level

*   statistically significant at a 10% level