Capital Expenditures, Financial Constraints, and the Use of Options

Tim Adam*

M.I.T. - Sloan School of Management
50 Memorial Drive, E52-403A
Cambridge, MA 02142, USA

Tel.: (617) 253-5123
Fax: (617) 258-6855
E-mail: *tadam@mit.edu*

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Abstract

This paper investigates why firms use options in the context of corporate risk management. I find that the use of options is positively correlated with firms' investment expenditures and acquisition activities. While financially unconstrained firms tend to buy options to hedge their future capital expenditures, financially constrained firms are more likely to sell options in order to raise funds to partially support their current capital expenditures and acquisition activities. Firms whose exposures are non-linear, e.g., due to the existence of real options, are also more likely and more extensive users of options strategies. Firms' hedging instrument choices are also correlated with current market conditions. When asset prices decline firms shift away from hedging with forwards and buy put options instead. When price volatility increases firms shift away from asymmetrical hedging strategies (only puts or only calls), and use symmetrical hedging strategies (forwards and collars) instead.

JEL Classification: G32

1 Introduction

The use of options as risk management tools is widespread among corporations. For example, the Wharton/CIBC 1998 risk management survey reports that 68% of non-financial firms that use derivatives also use options. The gold mining industry is no exception: 62% of derivatives users hedge their gold price exposures with options.[1] The three main options strategies are: buying put options on gold (15%), selling call options (12%), and buying collars (32%). Interestingly, about 28% of firms that use derivatives sell more calls than they buy puts.

Options positions are clearly an important part of the derivatives portfolios of many firms. However, our knowledge as to why firms use options is extremely limited. This study tries to shed light on this question. It comprehensively evaluates options strategies in the North American gold mining industry, and focuses on three main questions: First, are there cross-sectional differences between firms that use options strategies and firms that use linear hedging strategies? Second, among option users why do some firms buy options while others sell options? Third, do market conditions affect firms' hedging instrument choices?

There are several theoretical models that predict when firms should use options to hedge their risk exposures. For example, Froot, Scharfstein and Stein (1993) show that if a firm is financially constrained and if its future capital expenditures are a non-linear function of some risk exposure, then options may be necessary to achieve the value-maximizing hedge. Adam (2002) extends the Froot, Scharfstein and Stein (1993) model to an inter-temporal setting, and shows that financially less constrained firms tend to buy options, while financially more constrained firms tend to sell options. Adler and Detemple (1988), and Moschini and Lapan (1995) show that the

[1] The average fraction of the future gold production that has been hedged with options is 33%.

optimal hedging portfolio contains options if hedgeable and non-hedgeable risks are correlated. Brown and Toft (2002) show that this result can hold even if hedgeable and non-hedgeable risks are uncorrelated. In Adler and Detemple (1988) firms also use options because they face borrowing or short-selling constraints. Finally, Moschini and Lapan (1992) consider a firm's option to choose certain production parameters after product prices are observed. Assuming hedging is desirable, hedging this production flexibility (a real option) optimally requires non-linear hedging instruments, i.e., options. Common to all of these theories is the insight that if the exposure to be hedged is non-linear then a non-linear hedging strategy is optimal.

In order to test the empirical relevance of the above theories, I examine the use of options strategies in the North American gold mining industry over a 10 year horizon, between 1989 and 1999. The gold mining industry represents an excellent laboratory for this study because gold mining firms make intensive use of options strategies, and to my knowledge no other industry reveals similarly detailed information about their derivatives portfolios. Furthermore, gold mining firms share a relatively simple risk exposure: the future price of gold. Therefore, differences in hedging strategies are more likely the result of differences in certain firm-specific characteristics rather than differences in exposures.

I find that gold mining firms with high capital expenditures are more likely to hedge their future gold sales using options. They also use options to a larger extent. These results support the Froot Scharfstein and Stein (1993) model, in which financially constrained firms hedge in order to match their cash inflows with their cash outflows, i.e., their (non-linear) capital expenditures. In addition, I find that financially constrained firms tend to sell options while financially unconstrained tend to buy options, which is consistent with Adam's (2002) extension of the FSS model. Thus, while both financially constrained and unconstrained firms may have incentives to use options, they use different options strategies: Financially unconstrained firms buy puts to hedge their future capital expenditures, while financially constrained firms sell calls to raise funds to support their current capital expenditures.

It is common among gold mining firms to finance the purchase of puts by selling calls (hence creating collar strategies). Sometimes, however, firms sell more calls than they purchase puts (28% of option users). I find that firms with large investment programs and firms that engage in acquisitions write options more extensively. These firms also appear to be more financially constrained. Furthermore, the amount of options they sell is negatively correlated with the amount of external cash raised through equity and debt offerings. These results suggest that financially constrained firms sell options in order to raise funds to support their current investment and acquisition activities. Given firms' inherent long position in gold, selling calls on gold may be a cheaper form of financing than issuing regular debt.

Firms that enjoy more production flexibility, due to the presence of real options, are also more likely and more extensive users of options strategies. A firm's option to adjust output as a function of current market conditions implies that the exposure is non-linear. While the presence of real options may reduce the need for hedging, they increase the need for options strategies because non-linear exposures are most efficiently hedged with non-linear instruments.

Finally, I find that firms' hedging instrument choices are correlated with current market conditions: the gold spot price and the gold price volatility. When gold prices decline, firms reduce their use of linear strategies (forwards) and switch to options strategies instead. In particular, they hedge their gold sales by buying put options. Thus, it appears that when gold prices decline firms prefer not to lock in a relatively low price with a forward contract, but hedge the downside risk with a put option in order to maintain the upside potential.[2]

Furthermore, I find that volatility is negatively correlated with the use of some options strategies. At times of high gold price volatility firms reduce their use of strategies that result in asymmetric payoff profiles (buying puts *or* selling calls), and increase their use of strategies with symmetric payoff profiles (linear strategies and collars). These are peculiar results that may be driven by managers' willingness to speculate. For example, if the gold price volatility is high puts appear to be extensive, while calls are more likely to expire in-the-money, thus discouraging the speculative use of both strategies. Interestingly, these effects do not exist for the largest 10% of firms. Thus, speculative elements appear to be more prevalent among smaller firms than the industry leaders.

There are no comprehensive studies on the corporate use of options as hedging instruments. Tufano (1996) describes the different risk management strategies used by gold mining firms. Consistent with the results in this paper he finds that large firms are more likely to use options. A couple of papers examine other types of derivatives used as part of their analyses. For example, Geczy, Minton and Schrand (1997) find that firms are more likely to use currency swaps if they have more foreign-denominated debt, while they are more likely to use other types of currency derivatives, e.g., forwards, futures and options, if they receive more income from foreign sources. In a clinical study of a global durable goods manufacturer Brown (2001) finds that concerns about accounting treatments and the firm's competitive position affect its hedging instrument choices.

In contrast to the lack of studies on firms' hedging instrument choices, there are

[2] This rationale is also cited by Merck & Co., Inc. "Given the possibility of exchange rate movements in either direction, we were unwilling to forgo the potential gains if the dollar weakened; so options were strictly preferred." (see Lewent and Kearney, 1990, pp. 26-27) Indeed, a common reason for why firms prefer to hedge with options is because options allow a hedger to protect the downside while maintaining some upside potential.

several studies that examine hedging strategies in the gold mining industry. Tufano (1996) analyzes the determinants of the decision and the extent of hedging. He finds that hedge ratios are higher among firms that keep less liquidity and lower among firms that reward their executives with more stock options but less shares of the company. In a second paper, Tufano (1998) studies the gold price exposures of a cross-section of gold mining firms, and finds that hedging has only a marginal effect on a firm's stock price sensitivity to gold prices. Petersen and Thiagarajan (2000) show that differences in operating cost structures can lead some firms to use financial hedges and others to use operational hedges to mitigate gold price risk. Brown, Crabb and Haushalter (2004) examine whether gold mining firms adjust their hedge ratios due to their expectations about future gold prices, and find some supporting evidence. Finally, Adam and Fernando (2005) find that gold mining firms earn significantly positive cash flows from their derivatives transactions, which they link to the existence of a risk or forward premium in the gold market.

The rest of the paper is organized as follows. Section 2 describes the sample and risk management strategies in the gold mining industry. Section 3 summarizes the theoretical foundations of why firms should or should not use options. Sections 4 and 5 present the empirical results, and Section 6 concludes.

2 The Sample

The sample firms are those included in the *Gold & Silver Hedge Outlook*, a quarterly survey conducted by Ted Reeve of Scotia Capital from 1989 to 1999. The survey contains information on the gold derivatives positions of 118 gold mining companies, which represent most firms in the North American gold mining industry. Firms that are not included tend to be small and privately held corporations. Appendix A provides an example of the survey data. No other industry discloses similarly detailed information about their derivatives positions.

The industry focus implies that the sample firms share similar risk exposures. This turns out to be an advantage because differences in the observed hedging strategies are not merely a reflection of differences in exposures, but are more likely the result of differences in certain firm-specific characteristics. In order to create a homogeneous group of firms that face similar risk exposures, firms whose primary business segment is not gold mining (SIC code 1040 or 1041) are excluded. This exclusion applies only to FMC Corp. Appendix B lists all firms included in this study.

Most financial data are obtained from the Active, Canadian, and Research tapes of the Compustat database. Financial data of firms included in the survey but not covered by Compustat are collected by hand from firms' annual reports and 10-K forms. Operational data, such as production and reserve statistics, cash production costs and mining technologies are also collected by hand from firms' annual reports and 10-K forms. Financial market data, such as gold spot and futures prices, and interest rates, are obtained from Datastream. The variables and their constructions are summarized in Table 1.

Table 2 provides descriptive statistics of the 101 sample firms for which financial data was available. The distribution of the market value of assets is highly skewed and indicates that the gold mining industry consists primarily of small firms and a few large producers. The market value of assets ranges from \$3 million to about \$12 billion, while the mean and median values are \$1039 million and \$235 million respectively. The two Herfindahl indices confirm that most gold mining firms focus solely on gold mining activities. The mean Herfindahl index based on asset segments is 0.95, while the mean Herfindahl index based on metals production is 0.87.

Firms' investment programs are substantial. The average firm spends 24% of its invested capital or 50% of its sales (not reported) on capital expenditures every year. About 10% of sales are spent on exploration activities. On average, firms operate 3 mines, and extract 54% of their gold production from open-pit mines (as opposed to underground mines).

In the 1990's the average profit margin over production costs (excluding non-cash items such as depreciation, amortization and depletion) was only 30%, and some companies were not even able to recover their cash production costs. Consequently, most gold producers maintain relatively low leverage levels, relatively high cash balances and pay no dividends. The median leverage ratio is 0.17, while the median quick ratio is 1.62. If dividends are paid, the payout ratios are generally low, 10% of the operating cash flow on average. Reflecting the generally low debt levels, interest coverage is high and Altman's z-score (not reported) indicates that most firms face only a remote probability of bankruptcy in the short-term.[3] Furthermore, most gold mining firms have no credit rating (84%), and if a rating exists it tends to be below investment grade. The fact that most firms have little debt outstanding indicates that most firms are not sufficiently credit worthy to attract significant amounts of debt. Indeed, a relatively high debt level signals that a firm's cash flows are sufficiently stable to support debt. It is typically the largest firms, which operate many different mines, and hence have the most predictable cash flows, that also have the highest debt levels. Cases of overleveraged companies are rare in the gold mining industry.

In summary, a typical gold mining firm is a fairly small enterprise, which focuses exclusively on gold mining and operates under a slim profit margin. To support its investment program it raises external financing mostly in form of equity. The average firm pursues a conservative financial policy, has no public debt outstanding, and pays

[3]No bankruptcies or liquidations occurred during the sample period. Attrition in the sample was primarily due to mergers and acquisitions.

no dividends.

2.1 Risk management in the gold mining industry

Gold mining companies face two principal risk exposures: Gold price risk, which arises from the firms' major asset: the gold reserves in the ground, and production risk. In contrast to price risk, production risk is usually not hedgeable or insurable due to moral hazard or adverse selection. Gold price risk can be hedged, however, and the hedging of it is widespread. Between 1989 and 1999, on average 70% of gold mining companies used derivatives. Despite relatively similar risk exposures hedging strategies differ tremendously. To manage gold price risk mining firms have been using forwards and spot-deferred contracts, put and call options, and gold loans (see Figure 1).[4]

Options positions are an important part of the derivatives portfolios of most firms. About 62% of firms that use derivatives use options, while 7% of firms rely on option strategies exclusively. The average fraction of the future gold production that has been hedged with options is 33%. There are three primary option strategies: buying put options (15%), selling call options (12%), and collar strategies (32%). Interestingly, about 28% of firms that use derivatives sell more calls than they buy puts.

Option usage is not a recent phenomenon. Figure 2 shows that the fraction of firms that use both options and linear strategies has increased from 30% in 1989 to 55% in 1999. The fraction of firms that use linear strategies only has been generally declining. Figure 3 shows that the extent of option usage (fraction hedged with options) has seen significant volatility without discernible trend. However, the net

[4] The aggregate risk management portfolio consists of the derivatives positions of all firms in the sample. Its characteristics differ from the sample statistics because the aggregate portfolio is skewed towards the larger hedgers.

option position, which measures the difference between put and call positions, shows that between 1989 and 1999, the industry as a whole shifted from net buying of (put) options to net selling of (call) options.

3 Should Firms Use Options?

Many risk exposures can be hedged with simple forward contracts. Why then do many firms rely on more complex options strategies? An often heard argument is that (put) options allow a hedger to protect the downside while maintaining the upside potential. But, is such objective consistent with a pure hedging rational, or is it simply an indication that managers incorporate a market view into their hedging programs? Equally puzzling is that some firms sell call options. Can a short call option position be considered a hedge for a gold mining company, or do managers simply sell calls because they expect the gold price to fall in the future?

There are a number of theories that explain why options may be necessary to construct an optimal hedge. Common to all theories is the insight that if the exposure to be hedged is non-linear, then the optimal hedging strategy is also non-linear, i.e., contains options. The literature has proposed several factors that cause exposures to be non-linear. For example, Froot, Scharfstein and Stein (1993) argue that firms, which are financially constrained, may hedge their future capital expenditures so as to reduce their dependence on external funding sources. If firms' investment expenditures are non-linear then the optimal hedging strategy would also be non-linear. [5] The following quote is consistent with a relationship between capital expenditures

[5] MacKay (2005) has shown that production costs in the oil industry are a non-linear function of the oil price. In the gold mining industry investment expenditures are likely to be non-linear also. Consider a mining company, which would develop an existing gold reserve only if the gold price were to rise above some threshold. The firm would need to raise capital to build the mining facilities, etc. only if the gold price rose above that threshold, but would have no financing needs if gold prices remained low. Thus, the firm's capital requirement is a step function.

and hedging.

> "Generally the Group does not hedge its exposure to gold price fluctuations and sells at market spot prices. However, in periods of capital expenditure or loan finance, the Company secures a floor price through simple forward contracts and options whilst maintaining significant exposure to spot prices." (2001 Annual Report of Randgold Resources Corp.)

Chacko, Tufano, and Verter (2001) discuss an example of hedging future capital expenditures at Cephalon, Inc. The firm was waiting for approval to market a particular drug. If approval were granted, the firm would face significant cash needs. Management expected that approval would cause the firm's share price to rise significantly. To guarantee sufficient funds should the approval for the drug be granted, Cephalon's management decided to purchase call options on its own stock. The options would payoff handsomely should approval be obtained and Cephalon's share price rise.

Adam (2002) extends the Froot, Scharfstein and Stein (1993) model to an intertemporal setting in order to capture the fact that options affect cash flows in multiple periods. In his model firms equalize the marginal benefit of cash by shifting cash flows not only across states of nature but also across time. A financially constrained firm is characterized by a currently high marginal benefit of funds. It will shift cash flows from future states, in which the marginal benefit of cash is low, i.e., when the firm anticipates a cash surplus, to the present. For a gold mining firm this objective can be achieved by selling calls on gold.[6] A financially unconstrained firm is characterized

[6] If a firm's financial condition is sufficiently weak it may be willing to give up much of its upside potential and raise cash by selling calls. For example, in 1998, Kinross Gold Corp sold call options worth $2.1 million to partially pay for the acquisition of Amax Gold. The following year, another year of major acquisitions, Kinross sold additional calls worth $4.5 million. Other firms that have sold substantial number of call options include Cambior and IAM Gold.

by a currently low marginal benefit of funds. It will shift cash flows from the present to future states, in which the marginal benefit of cash is high, i.e., when the firm anticipates a cash shortage. For a gold mining firm this objective can be achieved by buying puts on gold. If the marginal benefit of cash is already equalized across time, then firms shift cash flows only across states of nature by using standard forwards or zero-cost collars.

Other authors have also examined the demand for options. Adler and Detemple (1988) show that in a portfolio context borrowing and short-selling constraints can cause exposures to be non-linear, and thus require options. In a corporate context such constraints may be represented more generally by financial constraints. In Moschini and Lapan (1992) a firm is given the option to choose certain production parameters *after* product prices are observed. Assuming hedging is desirable (the authors assume that the firm is risk-averse), hedging this production flexibility option (a real option) optimally requires non-linear instruments, i.e., options. Moschini and Lapan (1995) show that if hedgeable and non-hedgeable risks are correlated, then the optimal hedging portfolio is also non-linear. Unfortunately, gold prices and production risks (non-hedgeable risks) tend to be uncorrelated, because the gold production of an individual firm has no measurable impact on the gold price, which is determined by world demand and supply. Thus, there must be other reasons as to why gold mining firms use options. Brown and Toft (2002) extend Moschini and Lapan's (1995) work and show that the mere *existence* of non-hedgeable risks, or risks that for some reason are not hedged, can cause an exposure to be non-linear. The greater the magnitude of non-hedgeable risks, the greater would be the incentive to use options.

A number of authors have written on the decision to buy versus sell options. For example, Franke Stapelton and Subrahmanyam (1998) show that in the presence of non-hedgeable risks risk-averse investors prefer to buy options, while in the absence of such risks investors prefer to sell options. The intuition is similar to Leland (1980), who shows that agents whose risk tolerance increases with income purchase portfolio insurance from agents whose risk tolerance increases less rapidly. Since shareholders do not necessarily act in a risk-averse manner, it is not clear whether this theory applies in a corporate context. Even if it did apply, it would predict that most firms buy options, because essentially all firms are subject to non-hedgeable risks. This is clearly not the case. Approximately 29% of the sample firms sell options.

Brown and Toft (2002) show that firms should buy options if price and quantity risks are negatively correlated, and sell options if price and quantity risks are positively correlated. This idea also fails to explain risk management choices in the gold mining industry. As argued previously, gold price risk is uncorrelated with firms' production risks, but the use of options is widespread.

In contrast to the theories of option usage stands the possibility that options are used to implement managers' market views. For example, a manager who hedges with puts rather than with short forwards could signal that he believes that maintaining the upside potential is beneficial, which would indicate a market view on his part. Indeed, I conducted a survey among 30 gold mining companies, which revealed that after 'size of exposure' the most important determinants of instrument choice are market conditions, such as volatility, expected future spot prices, and liquidity of contracts. I will therefore test to what extent market conditions, such as gold prices and the gold price volatility, affect option strategies.

4 Results

The previous discussion revealed that the use of non-linear hedging strategies (options) should be correlated with firms' investment expenditures, financial constraints, non-hedgeable risks, and production flexibility (real options). I use two variables to measure the magnitude of firms' investment expenditures: the ratio of capital expenditures over net plant property and equipment (CAPX/PPE), and the ratio of exploration expenditures (expensed and capitalized) over sales.

To proxy for financial constraints I follow the existing empirical literature and use variables such as firm size, the market-to-book ratio, diversification, leverage, liquidity, interest coverage ratio, dividend policy, the existence of a credit rating, and a firm's profit margin. As pointed out previously, leverage levels in the gold mining industry are characteristically low. The fact that a firm has debt outstanding often indicates that it was sufficiently creditworthy to attract debt. In fact, it is typically the largest firms, which operate many different mines, and hence have the most predictable cash flows, that have the highest debt levels. The case of overleveraged firms is rare in the gold mining industry. Thus, a *low* leverage level should be interpreted as a sign of financial constraints.

I use two variables to capture the magnitude of non-hedgeable risks: production risk and diversification. Production risk is a classic example of a non-hedgeable risk. It is measured by the mean squared production forecast error defined by

$$MSE_t \equiv \frac{1}{k}\sum_{i=1}^{k}\left(\frac{\hat{y}_{t,t+i}-y_{t+i}}{y_{t+i}}\right)^2,$$

where $\hat{y}_{t,t+i}$ denotes the production forecast of year $t+i$ at time t, and y_{t+i} denotes the actual gold production in year $t+i$.[7] The second variable, diversification, measures a firm's exposure to various metal prices. The Herfindahl index is defined as follows:

$$\sum_{i=1}^{n}\left(\frac{s_i}{\sum_{i=1}^{n} s_i}\right)^2,$$

[7] Gold mining companies report these production forecasts in the derivatives surveys conducted by Ted Reeve from Scotia Capital. There are up to k production forecasts available at each point in time ($k_{\max} = 4$).

where s_i is the revenue contribution of each metal, and n is the total number of metals produced by the firm. A low index value indicates that a firm produces a variety of different metals, and hence is exposed to a variety of different metal prices. The metals that the sample firms produce are (in order of importance): gold, silver, copper, zinc, lead, and nickel. The rationale for using this variable is that the markets for many metals other than gold are less liquid, which implies that hedging non-gold exposures is costlier. In fact, most companies hedge their gold price exposures only.[8]

The existence of real options is measured by three variables: the number of mines in operation, the standard deviation of mine production costs, and the fraction of open-pit versus underground gold production. The more mines a firm operates, the more it is able to shift production from one mine to another in response to changes in market conditions. Thus, such a firm should enjoy more production flexibility (real options). Of course, if all mines had the same production costs, then this production flexibility would be less valuable. I therefore include the dispersion in mine production costs as an additional regressor. Firms that operate mines with different unit extraction costs benefit from volatility in gold prices because they can adjust their production costs by shifting production from low-cost mines to high-cost mines and vice versa. Similarly, open-pit mining provides firms with more production flexibility than underground mining due to the high fixed costs in underground mining. Firms have more flexibility to adjust production of open-pit mines than of underground mines if market conditions change. Although the existence of real options reduces the need to hedge, it causes the exposure to become non-linear and therefore warrant the use of options strategies.

[8] Strictly speaking, this variable is not a measure of the magnitude of non-hedgeable risks. However, it is a measure of the magnitude of risks that gold mining firms typically do not hedge.

4.1 The decision to use options

Table 3 contains probit model estimations of the decision to use options. The dependent variable equals one if a firm used options and zero if a firm used only linear hedging strategies (forwards, sport-deferred contracts, and gold loans). To account for the panel nature of the data set, I estimate random-effects and population-averaged probit models.[9]

The results show that firms with large investment programs and firms that are larger, less diversified, and do not pay dividends are more likely to use options strategies. To the extent that capital expenditures represent a non-linear exposures these results are consistent with Froot, Scharfstein and Stein (1993). Less diversified firms, and firms that do not pay dividends, are more likely to be financially constrained. These firms are more likely to use options strategies. Consistent with existing survey evidence, there is also a size effect: Larger firms, with potentially more complex exposures, or more sophisticated management, are more likely to use options. Other proxies of the non-linearity of the exposure (production uncertainty and metal diversification) are uncorrelated with the decision to use options. The existence of real options, however, appears to be important. Firms that operate more open-pit mines than underground mines, and hence have more production flexibility, are more likely users of options. The fact that these firms have the option to adjust output in response to changing market conditions implies that their gold price exposures are non-linear. Thus, hedging with non-linear instruments becomes optimal.

[9] One caveat in this study is that the sample is relatively small due to the industry focus. Therefore the results are potentially more sensitive to changes in the sample size than in large sample studies. I address this problem in three ways. (i) All tests are performed with and without outliers. Outliers are defined as the extreme 1% of values for each variable. (ii) Variables that reduce the sample size significantly are excluded in robustness checks. (iii) All tests are performed on the full sample and a subsample which excludes marginal hedgers (firms that hedge less than 10% of output). Whenever a change in the sample size significantly affected the results, all results are reported.

4.2 The extent of option usage

There are several ways to measure the extent of options usage. One possibility is to calculate the fraction of ounces of gold hedged with options.[10] Another possibility is to calculate the absolute value of the portfolio gamma. Gamma measures the curvature of a derivatives portfolio: Gamma is positive if the overall payoff profile is convex, and negative if the overall payoff profile is concave. Thus, the larger the absolute value of gamma, the more a firm relies on non-linear strategies. If a firm used linear strategies exclusively, the portfolio gamma would be zero.

There is a subtle but important difference between these two measures, however. Suppose a firm buys a put and sells a call with a higher strike price than the put (a collar), which is a frequently encountered hedging strategy in the gold mining industry. This strategy is picked up by the first measure, but less so by the second, because the gamma of a collar position may be very small. Thus, while the first variable measures the extent of option usage, the |portfolio gamma| measures the degree of asymmetry of the payoff profile of the derivatives portfolio.

Table 4 contains the results of the multivariate analysis. The |portfolio gamma| is strongly positively correlated with capital expenditures, while the fraction hedged with options is only weakly correlated. This implies that firms with large investment programs tend to either buy or sell options (asymmetric hedges), but use collar strategies less frequently. There is also some evidence that less diversified firms and firms that make no dividend payments use options strategies more intensely, but these statistical results are not robust. Lastly, firms that operate more open-pit than underground mines, and thus have more production flexibility, use options more

[10] However, a firm could buy puts and sell calls with identical strike prices. Even though the firm uses options, such position replicates the payoff of a forward contract (a linear hedging strategy), and should therefore not be counted towards options hedges.

extensively.

To summarize, the empirical results indicate that firms tend to use options strategies to hedge non-linear exposures. Firms with large investment programs and firms that are more likely financially constrained, are more likely users of options, and use options to a larger extent. The use of options strategies is also more common among firms that have more production flexibility, and thus face non-linear exposures. The following section will show why asymmetric options strategies rather than symmetric options strategies (collars) are correlated with capital expenditures, and why the results with respect to financial constraints are statistically weak.

4.3 Who buys and who sells options

Adam (2002) predicts that financially unconstrained firms are more likely to buy options, while financially constrained firms are more likely to sell options. Thus, both constrained and unconstrained firms have incentives to use options, but use different options strategies, which would explain the weak statistical results with respect to financial constraints in the previous section. To test this hypothesis I divide the sample into firms that buy options, firms that sell options, firms that both buy and sell, and firms that do not use options, and compare options buyers with options sellers.

The univariate results, reported in Table 5, reveal significant differences between option buyers and option sellers. Firms that buy options are more diversified than firms that sell options, maintain higher leverage levels, are more likely to have a credit rating, are more likely to pay dividends, and if dividends are paid, choose higher payout ratios. In addition, option buyers tend to be larger, have fewer growth options (proxied by the market-to-book ratio), keep less liquidity, have a higher credit rating (if one exists), and operate under higher profit margins than options sellers, although these results are not statistically significant at conventional levels. Overall, however, firms that buy options appear to be less financially constrained than firms that sell options.

The multivariate analysis, reported in Table 6, confirms this conclusion. The probit models of the decision to buy versus sell options shows that option buyers are more diversified (lower Herfindahl indices), maintain higher leverage levels, and are more likely to pay dividends than firms that sell options. To further test the robustness of these results, and to include firms that both buy and sell options into the analysis, I calculate a net option position, defined by (puts - calls)/(puts + calls). This ratio measures the relative size of the put position relative to the call position. It is bounded between 1 (100% puts) and -1 (100% calls). See Table 1 for details. Consistent with the previous results I find that firms that buy more puts (relative to calls) tend to be more diversified, more highly levered, and more likely to pay dividends. Thus, option buyers appear to be less financially constrained than option sellers.

4.4 Why firms sell options

Often firms sell calls to finance the purchase of puts, and thus create zero-cost collars. However, approximately 28% of firms that use derivatives sell more calls than they buy puts as shown in Table 7. Among these firms the average number of calls sold (in excess of puts) is 213,130 oz per annum, reaching a maximum of 3,100,000 oz. In comparison, the average size of a firm's derivatives portfolio was 675,000 oz between 1989 and 1999.

While buying puts can be regarded as an ordinary hedge for a gold mining firm, it is more difficult to interpret selling calls as a hedge. It could, however, be a 'cheap' form of financing for mining firms, due to the lower credit risk inherent in a short call position compared to a standard debt contract.[11] Indeed, sometimes substantial call positions are sold in connection with major acquisition activities. For example, in 1998, Cambior acquired the Doyon mine in an all cash transaction worth $98 million, and sold calls on 1.2 million oz of gold. In 1999, Placer Dome acquired the Zaldivar mine and sold calls on 2.1 million oz of gold. These cases suggest that firms may be selling options in order to raise cash to partially fund their acquisition expenditures.

Financially constrained firms would benefit most from such strategy, because for a mining firm that is long in gold (due to its gold reserves) the credit risk inherent in short call positions is less than the credit risk in a regular debt issue. To examine why firms sell options I first test whether net sellers of options are ex ante more financially constrained than other derivatives users (the previous section already showed that sellers are more constrained than buyers). Second, I test whether the number of options sold (net of options purchased) is related to firms' expenditures for acquisitions, investments and exploration activities. I will also examine whether firms that sell significant amounts of options reduce their fund raising from other external sources.

Table 8 presents the multivariate analysis of the differences between net sellers of options and other derivatives users. The results show that net sellers of options are less diversified, maintain less leverage, are less liquid, and are less likely to make dividend payments. These results are consistent with those in Table 6, and indicate that net sellers of options are likely to be more financially constrained than other derivatives users. Similar to Table 6, there is also a size effect: larger firms are more likely to be net sellers of options.

Table 9 presents regression models of the number of call options sold (in excess of

[11]The firm's obligation from a written call is covered by its inherent long position in gold (the gold reserve in the ground).

put options purchased). The results show that the selling of options coincides with acquisition activities, but the size of the acquisition is not related to the number of options sold. However, the magnitude of capital expenditures is strongly positively correlated with the number of options sold. Furthermore, in years in which firms sell many calls, the cash raised from other external sources (financing net cash flow) is relatively low. Thus, the results suggest that firms sell calls to raise funds to partially finance their capital and acquisition expenditures. Their dependence on other external funding sources declines.

To summarize, the use of option strategies is related to firms' capital expenditures and acquisition activities. While financially unconstrained firms appear to buy options to hedge their future capital expenditures, financially constrained firms write options to raise funds to partially support the current capital expenditures and acquisition activities.

5 Do market conditions affect options strategies?

> Which instruments we use is influenced by market conditions (contango, volatility levels, spot market trends and forecasts), as well as by our shareholders." Christopher Hill, Vice President & Treasurer of Kinross Gold Corporation, 2002.

Apart from hedging and fund raising considerations, market conditions may also influence how managers hedge their exposures as the above quote indicates. For example, after the gold price has declined, firms may be reluctant to lock in the relatively low gold price with a forward contract, but hedge instead by purchasing put options so as to maintain the upside potential. When the gold price volatility is high, managers may refrain from buying options because options appear expensive.

The quarterly nature of the data set allows a limited time-series analysis to examine how changing market conditions affect firms' hedging instrument choices. To characterize the structure of firms' derivatives portfolios, I use the same three variables that have been used in the previous analysis. The fraction hedged with options measures the extent of option usage, while the |portfolio gamma| measures the degree of asymmetry of the derivatives portfolio. The net option position measures the curvature of the derivatives portfolio: If the payoff of the portfolio is convex, the net option position is negative, while if the payoff is concave, the net option position is positive. See Table 1 for further details.

The time-series graphs of the three measures are shown in Figure 3 for the aggregate industry derivatives portfolio.[12] While there is no discernible trend in the extent of options strategies in general, the gold mining industry has clearly shifted from convex strategies (buying of options) to concave strategies (selling of options) between 1989 and 1999. Over the same sample horizon, the gold price generally declined. In order to remove the obvious time trend in the data the following analysis is based on changes in all variables.

Table 10 presents time-series regressions for all three variables on the gold price and the gold price volatility. All regressions are estimated using a fixed-effects model, an OLS model that includes the regressors used in the previous analysis instead of fixed-effects (called cross-section dummies), two fixed-effects models for the largest 10% of firms (in terms of market values) and the smallest 90% of firms, and a pure time-series model for the aggregate industry derivatives portfolio.

The results in Panel A show that the fraction hedged with options is negatively correlated with the gold price, but this relation does not exist for the largest 10%

[12] The aggregate industry derivatives portfolio consists of the derivatives portfolios of all firms in the sample, and is therefore skewed towards large firms.

of firms (the industry leaders), and therefore also does not show up in the aggregate derivatives portfolio. The same negative relation is observed between the |portfolio gamma| and the gold price. These results imply that when gold prices decline, firms increase their use of option strategies in general, and chose hedging portfolios that are increasingly asymmetrical. Thus, when gold prices decline, firms prefer not to lock in the relatively low gold price with forward contracts, but choose options strategies instead.

In contrast, the gold price volatility is only correlated with the |portfolio gamma| but not with the fraction hedged with options. This implies that when volatility increases firms shift away from asymmetrical strategies towards symmetrical options strategies, such as collars. The use of linear strategies is not affected by changes in the gold price volatility. One possible explanation for this phenomenon is that firms regard volatility risk as undesirable, so that at times of high volatility firms choose strategies that have less sensitivity to changes in volatility.

Panel C shows that the net option position is negatively correlated with the gold price but uncorrelated with the gold price volatility. These results imply that when the gold price declines firms predominantly shift towards buying put options.[13] When the gold price increases, firms increase their short call positions. One interpretation of these phenomena is that when the gold price declines hedging needs become more pressing, but firms hesitate to lock in a relatively low gold price with a forward contract. Instead, they choose to hedge with put options, and thus maintain the upside potential. When gold prices increase, protecting the downside becomes relatively less important. Firms then sell their upside potential, possibly believing that prices are more likely to decline than to further increase.

[13] The previous results already showed that firms increase their use of option strategies in general, and chose portfolios that are increasingly asymmetrical.

In summary, the time-series results document a link between current market conditions and the derivatives instruments firms choose to hedge their exposures. When gold prices decline firms shift away from selling forwards to purchasing put options. When the gold price volatility increases firms shift away from asymmetrical hedging strategies (only puts or only calls) towards symmetrical hedging strategies (forwards and collars). These effects, however, do not exist for the largest 10% of firms, and therefore do not consistently show up in the aggregate derivatives portfolio. While these results do not prove a causal link between market conditions and instrument choices, they document stylized facts that are consistent with anecdotal evidence on how firms hedge.

6 Conclusion

The use of options as risk management tools is widespread among corporations. However, our knowledge as to why firms use options is extremely limited. This study tries to shed light on this question. It comprehensively evaluates options strategies in the North American gold mining industry, and focuses on three main questions: First, are there cross-sectional differences between firms that use options strategies and firms that use linear hedging strategies? Second, among option users why do some firms buy options while others sell options? Third, do market conditions affect firms' hedging instrument choices?

I find that the use of options strategies is related to firms' capital expenditures and real options. Firms with large investment programs are more likely and more extensive users of options strategies. Given that capital expenditures are often non-linear in nature, these results are consistent with Froot, Scharfstein and Stein (1996), who argue that financially constrained firms may find it beneficial to match cash inflows with cash outflows. Indeed, I find that financial constraints affect options strategies. While financially unconstrained firms tend to buy options to hedge their future capital expenditures, financially constrained firms are more likely to sell options to raise funds to partially support the current capital expenditures and acquisition activities.

Firms that have more production flexibility (real options) are also more likely and more extensive users of options strategies. A firm's option to adjust output as a function of current market conditions implies that the exposure is non-linear. Non-linear exposures are most effectively hedged with non-linear instruments, such as options.

I also find that firms' hedging instrument choices are correlated with current market conditions. When gold prices decline gold mining firms shift away from selling forwards to purchasing put options. This result is consistent with anecdotal evidence that firms prefer options because options protect the downside while maintaining the upside potential. Maintaining the upside potential may be especially desirable when prices are relatively low. Second, when the gold price volatility increases firms shift away from asymmetrical strategies (only puts or only calls) towards symmetrical strategies (forwards and collars). Thus, when volatility is high firms prefer low vega hedging strategies.

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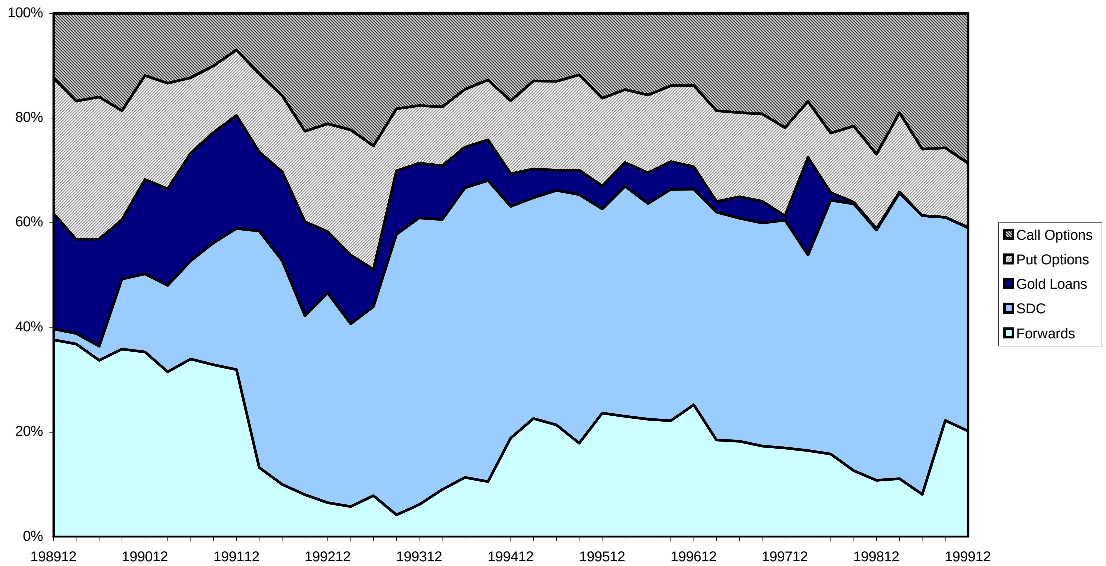

Figure 1: Composition of the Aggregate Derivatives Portfolio
This graph shows the evolution of the aggregate derivatives portfolio in the North American gold mining industry. The aggregate derivatives portfolio consists of all derivatives positions of the sample firms. The underlying asset of all derivatives is the gold spot price. Percentages refer to the notional principal of the derivatives positions. All put positions are long, while all call positions are short. SDC stands for spot-deferred contracts, which are similar to forward contracts except that delivery of the underlying asset can be deferred. Both SDCs and forwards are short.

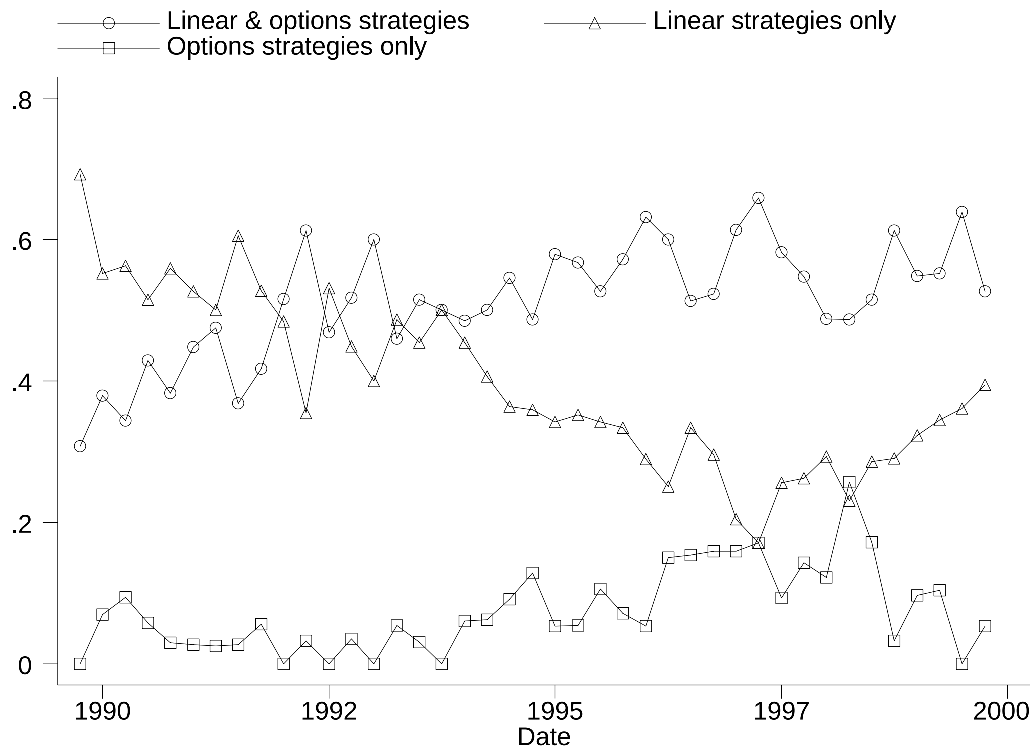

Figure 2: Fractions of Firms that Use Linear and Options Strategies

This figure shows the fraction of firms, among derivatives users, which use only linear strategies (forwards, spot-deferred contracts, and gold loans), only options strategies, and both linear and option strategies.

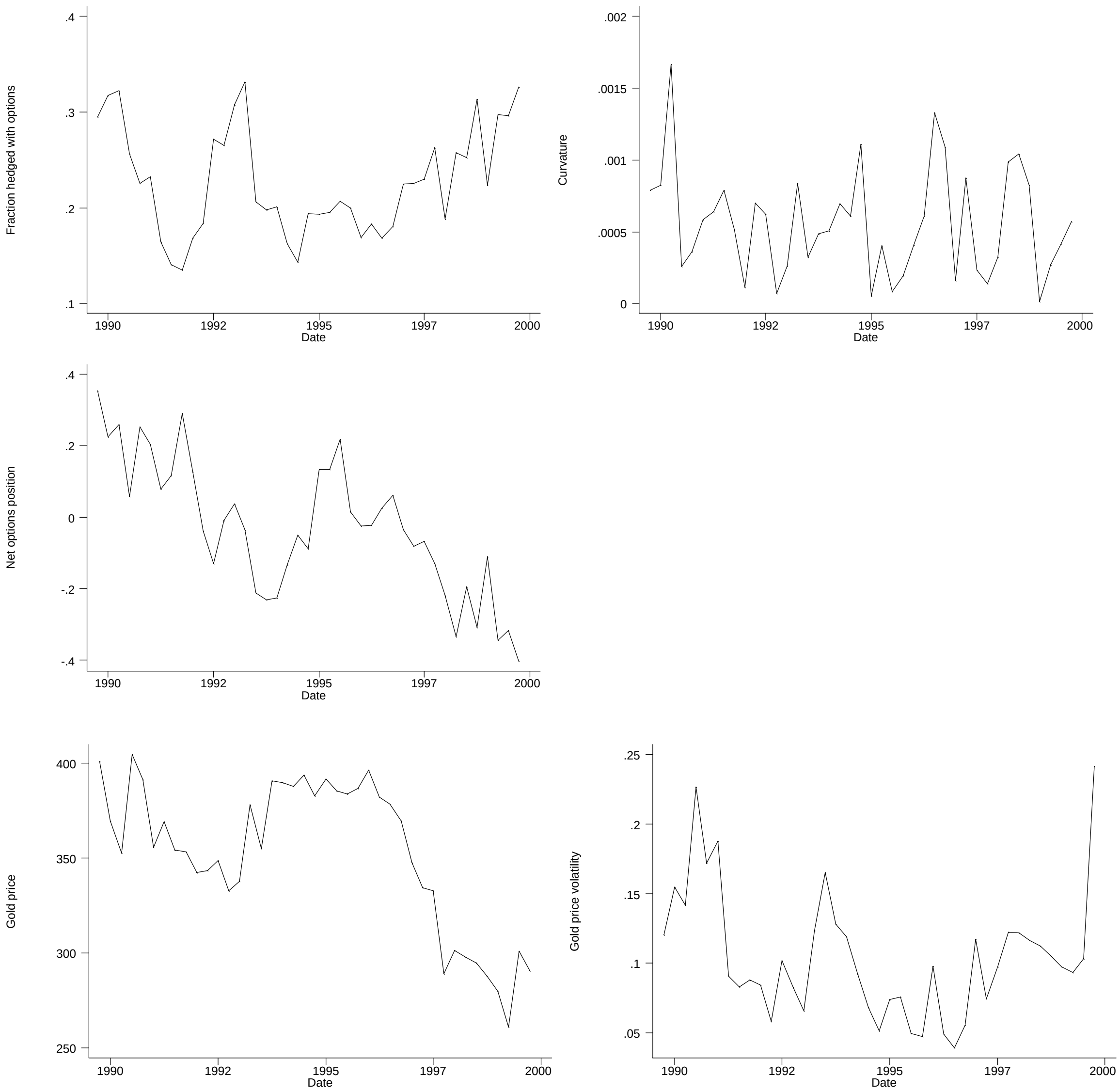

Figure 3: Time-series Characteristics of the Aggregate Derivatives Portfolio
The ‘fraction hedged with options’ is defined as the number of ounces of gold hedged with options divided by the total number of ounces of gold hedged. The ‘net option position’ measures whether the derivatives portfolio consists of predominantly of puts or calls. This measure is bounded between 1 (100% puts) and -1 (100% calls). The ‘curvature’ equals the absolute value of the portfolio gamma. It measures the degree of asymmetry in the payoff of the derivatives portfolio. Definitions of these variables can be found in Table 1. The last two graphs depict the gold price and the gold price volatility between 1989 and 1999. The gold price is given in US$/oz of gold. The gold price volatility is the annualized standard deviation of daily gold price returns over the previous 60 trading days.

Table 1: Variables Definitions and Data Sources

Variables	Construction
Principal data sources: Gold and Silver Hedge Outlook (1989 – 1999)	
Use of derivatives	Dummy variable that equals 1 if a firm had any type of gold derivative outstanding at the end of a quarter, and 0 otherwise.
Use of options	Dummy variable that equals 1 if a firm had option contracts on gold outstanding at the end of a quarter, 0 if only linear contracts were outstanding, and a missing value if a firm did not use any derivatives.
Fraction hedged with options	$\frac{\max\{\text{puts}, \text{calls}\}}{\text{all linear contracts} + \max\{\text{puts}, \text{calls}\}}$ Linear contracts, puts and calls are measured in ounces of gold. The max function ensures that collars, which consist of both puts and calls, are not double counted.
|Portfolio Gamma| = Curvature	Absolute value of gamma of the total derivatives portfolio per 1000 ounces of gold hedged. It measures the degree of non-linearity (asymmetry), of the hedging portfolio.
Buy vs. sell options	Dummy variable that equals 1 if a firm had long option positions (puts), and 0 if a firm had short option positions (calls) outstanding at the end of a quarter. In all other cases a missing value is assigned.
Net option position	$\frac{\text{puts} - \text{calls}}{\text{puts} + \text{calls}}$ This variable measures the relative size of the put position relative to the call position. It is bounded between 1 (100% puts) and -1 (100% calls).
Data sources: Datastream	
Gold price	Gold spot price in US$/ounce.
Gold price volatility	Annualised historical volatility (standard deviation) of the gold spot price using daily data over the previous 60 trading days.
Principal data sources: Compustat, annual reports & forms 10-K	
Market value of assets	Real market value of assets in 1999 dollars. Market value of assets equals book value of assets minus book value of common stock plus market value of equity. The producer price index for commodities is from the Bureau of Labor Statistics.
Market-to-book ratio of assets	Market value of assets divided by book value of assets. Market value of assets equals book value of assets minus book value of common stock plus market value of equity.
Herfindahl index (asset segments)	Defined by $\sum_{i=1}^{N}\left(\frac{q_i}{q}\right)^2$, where q_i is the book value of assets of industry

Variables	Construction
	segment i, and q is the total book value of all reported industry segment assets (non-reported assets such as financial assets are ignored). N is the total number of industry segments.
Herfindahl index (metals production)	Defined by $\sum_{i=1}^{N}\left(\frac{s_i}{s}\right)^2$, where s_i is the revenue contribution of each metal (estimated as metal production × spot price), and s is the total metal sales for the year. N is the total number of metals produced by the firm. If metal production is zero, a missing value is assigned. Metal prices are from Datastream.
Leverage	Book value of long-term debt divided by the book values of preferred stock, common equity, and long-term debt.
Quick ratio	Liquidity is measured by a firm's quick ratio, which is defined by (cash + cash equivalents + receivables) / current liabilities.
Credit rating dummy	Dummy variable that equals one if a credit rating exists and zero otherwise.
S&P credit rating	Standard & Poor's senior debt rating.
Interest coverage ratio	Interest expense (net of interest income?) divided by operating net cash flow. If the operating net cash flow is negative, a missing value is assigned.
Profit margin	Difference between gold spot price and cash costs divided by cash costs. Cash costs are the per-ounce extraction costs of gold.
Dividend dummy	Dummy variable that equals one if a firm paid cash dividends and zero otherwise.
Dividend payout ratio	Cash dividends paid during the fiscal year, divided by operating net cash flow. If the operating net cash flow is negative, a missing value is assigned.
CAPX / PPE	The size of the investment program is measured by a firm's capital expenditures divided by net plant property and equipment.
Exploration expenditures / sales	Expensed and capitalized exploration expenditures divided by sales.
Production uncertainty	Production uncertainty is measured by the mean squared production forecast error defined by $\frac{1}{n}\sum_{i=1}^{n}\left(\frac{y_{t,t+i}-y_{t+i}}{y_{t+i}}\right)^2$, where y_{t+i} denotes the actual gold production in year $t+i$, and $y_{t,t+i}$ denotes the production forecast for year $t+i$ at time t. There are up to n production forecasts available at each time (n_{max} = 4). Production forecasts are inferred from the Gold and Silver

Variables	Construction
	Hedge Outlook (1989 – 1999)
Number of operating mines	Number of operating mines per firm.
Standard deviation of production costs	Standard deviation of the production costs of each operating mine.
Fraction of open-pit production	Fraction of gold production that stems from open-pit mines relative to total production. The second major mining technique is underground mining.

Table 2: Descriptive Statistics of the Characteristics of Firm's Derivatives Portfolios

The construction of variables can be found in Table 1. The average maturity of the derivatives portfolio is the weighted average maturity of all outstanding derivatives contracts. The individual contract sizes are used as weights. The quarterly derivatives cash flows are the cash flows inferred from quarterly changes of all outstanding gold derivatives positions. See Adam and Fernando (2005) for details.

Panel A	***Mean***	***Median***	***Std. dev.***	***Min***	***Max***	***Obs.***
Use of derivatives (dummy variable)	0.698	1	0.459	0	1	2085
Use of options (dummy variable)	0.615	1	0.487	0	1	1444
Fraction hedged with options	0.333	0.202	0.363	0	1	1455
|Portfolio Gamma|	0.0020	0.0005	0.0034	0	0.0271	1450
Buy vs. sell options (dummy variable)	0.025	0	0.614	-1	1	895
Net options position (buy put vs. sell call)	0.021	0	0.685	-1	1	895
Gold price ($/oz)	352.47	355.25	38.02	261.15	404.75	2258
Gold price volatility (annualized)	0.101	0.097	0.044	0.039	0.242	2258

Panel B	***Mean***	***Median***	***Std. dev.***	***Min***	***Max***	***Obs.***
Market value of assets (in 1999 $ million)	1039.36	234.65	1867.42	2.85	11619	534
Market-to-book value of assets	1.84	1.56	1.06	0.30	5.91	534
Herfindahl index (asset segments)	0.95	1	0.16	0.23	1	585
Herfindahl index (metals production)	0.87	1	0.21	0.28	1	498
Profit margin	0.46	0.40	0.41	-0.53	1.87	470
Capital expenditures / PPE	0.24	0.19	0.23	0	2.72	539
Exploration expenditures / sales	0.10	0.05	0.17	0	0.97	393
Number of operating mines	3.86	3	3.05	1	18	268
Standard deviation of production costs	65.20	58.35	44.11	4.95	285.67	179
Fraction of open-pit production	0.54	0.54	0.41	0	1	267
Production uncertainty	0.23	0.03	0.64	0.00	3.64	251
Leverage	0.23	0.17	0.25	0	1.26	541
Quick ratio	3.41	1.62	6.01	0.01	35.62	531
Interest coverage ratio	18.03	5.43	45.57	0	320.30	409

Dividend (dummy variable)	0.43	0	0.50	0	1	546
Dividend payout ratio	0.10	0	0.19	0	0.97	528
Credit rating (dummy variable)	0.16	0	0.37	0	1	585
S&P credit rating	BBB-	BB+		B-	A	94

Table 3: Why Firms Use Options

The dependent variables equals 1 if a firm used options and 0 if a firm used only linear hedging strategies. Definitions of the regressors can be found in Table 1. The models are estimated with and without outliers (defined by the extreme 1% of values). Reported results are based on the estimations without outliers. Figures in parentheses denote t-statistics. Standard errors are calculated using the Huber/White/sandwich estimator, assuming that firm-year observations are independent across firms but not across years.

	Pred. sign	Random-effects probit models			Population-averaged probit models		
ln(CAPX / PPE)	+	0.348** (2.55)	0.787*** (3.37)	0.969*** (2.98)	0.292*** (2.77)	0.624*** (3.57)	0.831*** (3.23)
Exploration expenditures / sales	+		0.343 (0.20)	-2.990 (-0.74)		0.608 (0.44)	-2.487 (-0.74)
ln(book value of assets)	+/-	0.333*** (2.91)	0.288* (1.79)	0.827*** (2.56)	0.238*** (2.96)	0.200* (1.78)	0.664*** (2.73)
Herfindahl index (asset segments)	+	2.185*** (2.78)	3.382*** (2.69)	2.061 (1.47)	1.666*** (2.84)	2.478*** (2.90)	1.535 (1.43)
Dividend dummy	-	-0.649** (-2.04)	-0.889** (-2.09)	-2.007*** (-2.99)	-0.438** (-2.02)	-0.664** (-2.20)	-1.671*** (-2.96)
Credit rating dummy	-	0.427 (1.21)	0.061 (0.15)	-0.406 (-0.79)	0.286 (1.11)	0.055 (0.17)	-0.351 (-0.87)
Production uncertainty	+		-0.131 (-0.64)	0.420 (0.88)		-0.086 (-0.52)	0.345 (0.92)
Herfindahl index (metals production)	-	0.537 (0.82)	-0.248 (-0.30)	-2.528* (-1.90)	0.423 (0.85)	-0.242 (-0.38)	-2.118** (-1.96)
Number of operating mines	+			-0.113 (-1.23)			-0.091 (-1.32)
Standard deviation of production costs	+			0.000 (0.03)			0.000 (0.05)
Fraction of open-pit production	+			1.638** (2.26)			1.440** (2.47)

	Pred. sign	Random-effects probit models			Population-averaged probit models		
Wald test		21.34	20.50	19.92	23.05	25.34	24.68
Sig. level		0.002	0.009	0.046	0.001	0.001	0.010
R^2 from OLS		0.094	0.189	0.298	0.094	0.189	0.298
Total Observations / number of firms		335 / 75	194 / 49	117 / 26	335 / 75	194 / 49	117 / 26

Significance at the 1%, 5% and 10% levels is denoted by ***, ** and * respectively.

Table 4: Multivariate Analysis of the Extent of Options Usage

This table presents estimation results of random-effects tobit models. The first dependent variable is the fraction of ounces of gold hedged with options. By definition, it is bounded between 0 and 1. The second dependent variable is the absolute value of the gamma of a firm's derivatives portfolio per ounce of gold hedged. It measures the degree of non-linearity (asymmetry) of the derivatives portfolio. Definitions of the regressors can be found in Table 1. The models are estimated with and without outliers (defined by the extreme 1% of values). Reported results are based on the estimations without outliers. Figures in parentheses denote t-statistics.

	Pred. sign	Fraction of ounces of gold hedged with options			|Portfolio Gamma|		
ln(CAPX / PPE)	+	0.037 (0.56)	0.088 (1.39)	0.131* (1.76)	0.001*** (2.64)	0.002*** (3.31)	0.002** (2.55)
Exploration expenditures / sales	+		-0.426 (-0.80)	-0.686 (-0.69)		0.002 (0.58)	-0.002 (-0.23)
Production uncertainty	+		-0.039 (-0.54)	0.049 (0.57)		-0.000 (-0.53)	0.000 (0.53)
Herfindahl index (metals production)	-	-0.836** (-2.15)	0.248 (0.89)	-0.559 (-1.47)	0.000 (0.23)	-0.002 (-1.08)	-0.003 (-1.04)
ln(book value of assets)	+/-	-0.105 (-1.52)	0.060 (1.29)	0.092 (1.28)	0.000 (0.74)	-0.000 (-1.12)	0.001 (0.98)
Herfindahl index (asset segments)	+	1.173*** (2.61)	1.269*** (2.57)	0.449 (1.02)	0.005** (2.10)	0.005** (2.16)	0.003 (0.68)
Dividend dummy	-	-0.243 (-1.52)	-0.305*** (-2.93)	-0.357*** (-2.57)	-0.001 (-1.27)	-0.001 (-1.41)	-0.003** (-2.48)
Credit rating dummy	-	0.082 (0.39)	-0.067 (-0.61)	-0.102 (-0.67)	0.000 (0.15)	0.000 (0.20)	-0.000 (-0.04)
Number of operating mines	+			-0.020 (-0.83)			-0.000 (-0.83)
Standard deviation of production costs	+			-0.000 (-0.18)			-0.000 (-0.16)
Fraction of open-pit production	+			0.404** (-2.07)			0.004** (-2.27)

	Pred. sign	Fraction of ounces of gold hedged with options			|Portfolio Gamma|		
Wald test		22.02	27.25	18.24	14.96	29.34	22.32
Sig. level		0.001	0.001	0.076	0.021	0.000	0.022
R^2 from OLS		0.065	0.127	0.162	0.064	0.120	0.157
Total Observations / number of firms		470 / 84	194 / 49	117 / 26	329 / 74	193 / 49	116 / 26

Significance at the 1%, 5% and 10% levels is denoted by ***, ** and * respectively.

Table 5: Univariate Comparisons between Buyers and Sellers of Options

This table lists means (top figures) and medians (bottom figures) for three groups of derivatives users: buyers of put options, sellers of put options, and firms that buy and sell options simultaneously. The last column contains t-statistics and z-statistics based on the two-sample means test assuming unequal variances, and the two-sample Wilcoxon rank-sum test respectively. In order to obtain independent observations from the panel data set, firm-year observations are condensed into a median figure for each firm.

	Buyers of options	Firms that buy and sell options	Sellers of options	Buyers vs. sellers
ln(market value of assets)	6.24 6.23	5.51 5.18	5.62 5.24	1.322 1.394
Market-to-book value of assets	1.64 1.54	1.54 1.37	1.81 1.72	-0.688 -0.929
Herfindahl index (asset segments)	0.93 1	0.97 1	1 1	-1.766* -1.585
Herfindahl index (metals production)	0.86 1	0.91 1	0.92 1	-1.019 -1.038
Leverage	0.29 0.28	0.23 0.21	0.13 0.08	3.047*** 2.766***
Quick ratio	1.77 1.54	2.08 1.32	2.49 2.08	-1.095 -1.175
Interest coverage ratio	19.12 4.91	14.38 6.49	30.66 8.32	-0.725 -1.324
Altman's z-score (Prob. of bankruptcy)	2.23 1.81	2.47 2.21	5.38 4.33	-1.770 -1.278
Credit rating dummy	0.26 0	0.20 0	0.08 0	1.797* 1.559
S&P credit rating	BBB- BBB-	BBB- BBB-	BB BB	
Dividend dummy	0.54 0.75	0.39 0	0.21 0	2.395** 2.284**
Dividend payout ratio	0.13 0.04	0.08 0	0.06 0	1.309 1.765*
Profit margin	0.49 0.49	0.39 0.39	0.38 0.35	0.931 1.017
Average maturity of derivatives portfolio (years)	1.70 1.66	1.71 1.61	1.56 1.47	1.042 0.826

Significance at the 1%, 5% and 10% levels is denoted by ***, ** and * respectively.

Table 6: Multivariate Analysis of the Decision to Buy Versus Sell Options

In the probit regressions the dependent variable equals 1 if a firm bought (put) options, and 0 if a firm sold (call) options. In all other cases, e.g., if a firm bought and sold options simultaneously, a missing value is assigned. In the tobit regressions the dependent variable is the net option position, i.e., the number of puts relative to the total number of options used. By definition, this variable is bounded between 0 and 1. The definitions of the regressors can be found in Table 1. Figures in parentheses denote t-statistics.

		Buy versus sell options (dummy variable)		Net options position
	Pred. sign	Random-effects probit model	Population-averaged probit model	Tobit model
ln(market value of assets)	+/-	-0.517** (-2.03)	-0.645** (-2.66)	-0.137* (-1.79)
Market-to-book value of assets	-	0.464 (1.37)	0.511 (1.45)	0.160 (1.52)
Herfindahl index (asset segments)	-	-2.019 (-0.92)	-1.952 (-0.86)	-1.027* (-1.83)
Herfindahl index (metals production)	-	-4.876*** (-3.01)	-5.437*** (-3.10)	-0.522 (-1.13)
Leverage	+	5.364*** (3.18)	5.391*** (3.02)	1.265*** (2.86)
Quick ratio	-	-0.173 (-0.87)	-0.183 (-0.95)	-0.033 (-1.02)
Interest coverage ratio	+	0.007 (1.20)	0.006 (0.92)	-0.001 (-0.65)
Credit rating dummy	+	0.862 (1.13)	1.096 (1.44)	-0.030 (-0.15)
Dividend dummy	+	1.247** (2.14)	1.469*** (2.72)	0.390* (1.95)
Profit margin	+	0.625 (0.76)	0.801 (0.95)	0.093 (0.36)
Wald test		18.39	22.28	
Significance level		0.049	0.014	
Pseudo R^2		0.453	0.453	0.071
R^2 from OLS				0.168
Observations / number of firms		57 / 30	57 / 30	169 / 48

Significance at the 1%, 5% and 10% levels is denoted by ***, ** and * respectively.

Table 7: Descriptive Statistics

Derivatives data is derived from the Gold and Silver Hedge Outlook (1989-1999). See Appendix A for a sample of the raw data. Financial data is obtained from Compustat.

Variable	***Mean***	***Median***	***Std. Dev.***	***Min***	***Max***	***Obs.***
Firm is a net seller of options (dummy)	0.28	0	0.45	0	1	389
Number of calls sold net of puts bought (000s oz)	213.13	39.25	448.11	0.5	3100	109
Acquisition (dummy)	0.20	0	0.40	0	1	504
Acquisition expenditures / sales	0.11	0	0.48	0	4.92	471
Capital expenditures / sales	0.49	0.27	0.71	0	4.12	518
Exploration expenditures / sales	0.09	0.05	0.15	0	0.87	386
Extraordinary & special expenses / sales	0.01	0	0.23	-1.68	2.96	424
Non-operating expenses /sales	-0.08	-0.04	0.19	-1.47	0.26	438
Financing net cash flow / sales	0.46	0.06	1.83	-5.74	26.96	514

Table 8: Differences between net sellers of options and other derivatives users

This table contains multivariate tests that examine differences between net sellers of call options and other derivatives users. The dependent variable is a dummy variable that equals 1 if a firm is a net seller of calls and 0 if the firm uses other derivatives strategies. Figures in parentheses denote t-statistics.

	Random-effects probit models		Population-averaged probit models	
ln(market value of assets)	0.276*** (3.35)	0.222** (2.38)	0.262*** (3.43)	0.213** (2.37)
Market-to-book ratio of assets	-0.048 (-0.47)	0.019 (0.15)	-0.046 (-0.50)	0.015 (0.12)
Herfindahl index (asset segments)	1.651** (2.49)	1.381** (2.00)	1.476** (2.33)	1.274* (1.88)
Leverage	-1.372*** (-2.81)	-1.460*** (-2.65)	-1.269*** (-2.82)	-1.330*** (-2.61)
Quick ratio	-0.061* (-1.77)	-0.048 (-1.15)	-0.060** (-1.88)	-0.048 (-1.24)
Credit rating dummy	0.117 (0.40)	0.107 (0.36)	0.073 (0.29)	0.091 (0.35)
Dividend dummy	-0.624** (-2.51)	-0.558** (-2.06)	-0.600*** (-2.61)	-0.549** (-2.13)
Profit margin		-0.307 (-0.98)		-0.264 (-0.91)
Interest coverage ratio		-0.001 (-0.67)		-0.001 (-0.65)
Wald test χ^2	22.82	18.16	23.58	17.52
Significance level	0.002	0.033	0.001	0.041
R^2 from OLS				
Observations / number of firms	358 / 78	279 / 59	358 / 78	279 / 59

Significance at the 1%, 5% and 10% levels is denoted by ***, ** and * respectively.

Table 9: Determinants of the number of call options sold (in excess of put options bought)

The dependent variables in the following OLS regressions are the number of calls sold in excess of the number of puts bought. The sample consists of only those firms that are net sellers of call options. All variables are scaled by net sales. Standard errors are based on the Huber/White/sandwich estimator of variance to account for the dependency of observations within clusters (firms). Figures in parentheses denote t-statistics.

	Dependent variable: Number of call options sold (in excess of put options bought)	
Intercept	0.459** (2.63)	0.726*** (3.27)
Acquisition dummy	0.900* (1.99)	
Acquisition expenditures		0.219 (1.25)
Capital expenditures	1.286*** (4.43)	1.079*** (3.66)
Financing net cash flow	-0.293*** (-3.23)	-0.245** (-2.42)
Obs	92	92
R^2	0.129	0.064

Significance at the 1%, 5% and 10% levels is denoted by ***, ** and * respectively.

Table 10: The impact of market conditions on firms' hedging strategies

This table presents panel and time-series regressions of three option portfolio characteristics on the gold price and the gold price volatility. All regressions are performed on changes.

Panel A: Dependent variable: Fraction hedged with options

		Cross-section dummies	Top 10% (market value)	Bottom 90% (market value)	Industry portfolio Time-series
Intercept		-0.026 (-1.66)			-0.001 (-0.14)
Gold price	-0.001*** (-2.79)	-0.002** (-2.51)	-0.001 (-0.69)	-0.002*** (-2.65)	-0.000 (-1.34)
Gold price volatility	-0.127 (-0.54)	-0.023 (-0.09)	0.449 (1.20)	-0.256 (-0.95)	0.150 (0.87)
Fixed effects	Yes		Yes	Yes	
Obs.	758	690	131	627	40
R^2	0.015	0.017	0.044	0.020	0.061

Panel B: Dependent variable: Non-linearity of hedging portfolio = |Portfolio gamma|

		Cross-section dummies	Top 10% (market value)	Bottom 90% (market value)	Industry portfolio Time-series
Intercept		-0.000* (-1.74)			0.000 (0.01)
Gold price	-0.000*** (-3.45)	-0.000*** (-3.49)	-0.000 (-0.60)	-0.000*** (-3.43)	-0.000 (-0.54)
Gold price volatility	-0.018*** (-5.36)	-0.019*** (-5.48)	-0.003 (-0.90)	-0.022*** (-5.38)	-0.004** (-2.06)
Fixed effects	Yes		Yes	Yes	
Obs.	872	790	147	725	40
R^2	0.050	0.054	0.002	0.062	0.113

Panel C: Dependent variable: Net options position (buy put vs. sell call)

		Cross-section dummies	Top 10% (market value)	Bottom 90% (market value)	Industry portfolio Time-series
Intercept		-0.012 (-0.30)			-0.017 (-0.89)
Gold price	-0.003** (-2.24)	-0.003** (-2.28)	-0.000 (0.04)	-0.003** (-2.17)	0.000 (0.00)
Gold price volatility	0.352 (0.52)	0.049 (0.09)	-0.820 (-0.97)	0.541 (0.68)	-0.771* (-1.69)
Fixed effects	Yes		Yes	Yes	
Obs.	456	426	77	379	40
R^2	0.018	0.015	0.002	0.019	0.07

Appendix A
Hedge Positions of Placer Dome as of December 31, 1998

The first column in each panel lists the number of ounces of gold that must be delivered under various contracts. The second column lists the respective delivery prices, and the third column records the percentage of future gold production that has been hedged. The maturity year of all contracts is given on top of each panel. SDC stands for spot-deferred contracts. A spot-deferred contract is like a forward contract except that delivery can be deferred for several years at the discretion of the deliverer. If delivery is deferred, the new delivery price is set to equal the prior contract price plus the current contango premium.

	1999			2000			2001		
	Ounces	Price (US$/oz)	Percent of Prod.	Ounces	Price (US$/oz)	Percent of Prod.	Ounces	Price (US$/oz)	Percent of Prod.
Forwards	649,000	503		213,000	504		188,000	458	
SDC	390,000	397		737,000	440		442,000	441	
Puts	298,000	298		127,000	303				
Total	**1,337,000**		**44.0%**	**1,077,000**		**37.0%**	**630,000**		**23.5%**
Calls	521,000	310		115,000	371		100,000	365	

	2002			2003 and beyond		
	Ounces	Price (US$/oz)	Percent of Prod.	Ounces	Price (US$/oz)	Percent of Prod.
Forwards	30,000	429				
SDC	886,000	360		886,000	360	
Puts	200,000	300				
Total	**1,116,000**		**40.1%**	**886,000**		**32.3%**
Calls	200,000	365				

Source: Gold & Silver Hedge Outlook, Fourth Quarter 1998, Scotia Capital Markets