ON RISK MANAGEMENT DETERMINANTS: WHAT REALLY MATTERS?

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ABSTRACT

In this paper we investigate the determinants of the decision to manage gold price risk for an original quarterly dataset of North American gold mining firms. Our paper complements Tufano (1996) and Dionne and Garand (2003) work. We adjust the tax save variable proposed by Graham and Smith (1996) to get a more precise valuation of the tax incentive to hedge for the Canadian firms in our sample. Our evidence suggests that financial distress costs, information asymmetry, taxes, size and managerial risk aversion are important determinants of the decision to hedge. These findings do not support Tufano’s (1996) conclusion that risk management increases only the manager’s utility. We also report evidence suggesting that the composition of the board of directors and the non separation between the CEO and the chief of the board positions have no impact on the risk management decision. We then control for the endogenous relation between the debt and the risk management policies by using a system of simultaneous equations containing two Tobit models. In order to estimate the system, we extend, to panel data, the minimum distance estimator proposed by Lee (1995). In this case, the tax and size arguments loose their explanatory power, and the separation between the CEO and the chief of the board positions becomes a significant explanation of the decision to hedge. Finally, our results do not support Graham and Rogers (2002) conclusion that firms hedge in order to increase their debt capacity.

Keywords: risk management determinants, corporate hedging, capital structure, managerial incentive, gold price, tax incentive, minimum distance estimator, panel data.

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INTRODUCTION

Risk management has received a lot of attention in the financial literature. Several theories were put forward to explain why and how corporations manage (or should manage) the risks they face [e.g., Stulz (1984); Smith and Stulz (1985); Stulz (1990); DeMarzo and Duffie (1991); Froot, Scharfstein and Stein (1993); Morellec and Smith (2002), Breeden and Viswanathan (1998) and Carpenter (2000)]. However, as of yet, there is still not a unique, well-accepted framework that practitioners can rely on when formulating their risk management strategies. The absence of a consensus in the empirical findings is surprising, especially that several papers addressed the issue. The lack of quality data relative to the risk management activities and, consequently, the difficulty in constructing a variable that describe adequately the risk management policy in a firm, could be the cause of such situation. Indeed, hedging operations are usually off-balance and any details regarding them are impossible to find in widely used databases. Additionally, firms are often reluctant to disclose detailed information about their risk management policies, usually considered as being a strategic decision that can affect considerably their profitability. The lack of data makes tests of existing theories difficult to implement and leads to the impossibility to conclude whether these theories explain choices made by firms in the real world. In this paper, we overcome this problem by constructing a database that contains details on risk management operations for a sample of North American gold mining firms over a ten years period.

The literature on the risk management determinants falls in three groups. A first group of papers (e.g., Nance, Smith and Smithson (1993); Géczy, Minton and Schrand (1997), Jalilvand (1999)) uses dichotomous variables to separate companies holding derivatives from those that do not. These variables provide no quantitative information on the level of risk management adopted by a corporation and suppose that derivatives usage is a synonym of risk management, which is not always true. A second group of papers uses the total notional value of derivative contracts held by the firm for non-trading purposes (Allayanis and Ofek (2001); Gay and Nam (1999); Knopf, Nam and Thornton (2002)). Such variable may provide an erroneous estimate of the risk management activity especially when the firm holds offsetting contracts. In order to eliminate some of the critics addressed to these variables, Rogers (2002) and Graham and Rogers (2002) proposed a third approach based on the value of the net position held by the firm on derivative contracts for non-trading purposes. Unfortunately, this variable is also criticisable because it does not distinguish between the different derivative contracts and may lead to conclude that a firm having a $90 millions long position in options and a $50 millions short position in futures-a net position of $40 millions- is having the same risk management strategy as a firm having a long position of $40 millions only in the forward markets. Since a risk management strategy implies decisions concerning both the amount of risk to hedge and the instruments employed to hedge, using the net position as a measure of risk management leads to an information loss regarding the instruments. Tufano (1996) introduced a new measure of the risk management activity called the delta percentage defined as the delta of the risk management portfolio held by the firm divided by its expected production. This measure provides a complete quantitative valuation of the financial risk management activity for a corporation because it intervenes in its calculation information on both the level of hedging and the instruments utilised to hedge. The results reported by Tufano (1996), suggest that firms hedge only to increase their manager’s utility but not their value. However, these
empirical findings are limited for two main reasons. First, the sample size in the regressions is too small: 108 observations for the pooled regressions and samples as small as 34 observations for the yearly regressions, to fit 12 independent variables. Thus, one can hardly generalise the conclusions of the study. Second, Tufano (1996) uses a one sided Tobit model to run his pooled regressions. Such a specification treats a firm’s observations as independent in time which can lead to a potential overestimation of the p-values, and as a consequence, to possible erroneous conclusions. Building on Tufano (1996), Dionne and Garand (2003) formed a larger sample and estimated a random firm effect Tobit model to take into account the panel aspect of the data. The authors show that several arguments relative to the maximisation of the firm value do explain the risk management decision. However, their tests only consider financial determinants of the risk management decision and do not control for the management risk aversion. Their results could simply be due to a misspecification of their model. Indeed, managerial risk aversion is expected to affect considerably the risk management policy of gold mining firms, as initially stated by Tufano and more recently by Pertsersen and Thiagarajan (2000). One objective in this paper is to specifically test this hypothesis and provide some empirical support for it.

In order to study the determinants of the risk management decision, we collected detailed quarterly data on the risk management activities, financial and managerial characteristics for a group of North American gold mining firms. Our sample is five times greater than Tufano’s (1996) and our methodology takes into account the panel aspect of the data. Going beyond Dionne and Garand (2003), we consider managerial risk aversion variables in addition to financial variables, as potential determinants of the risk management decision. We also adjust the tax save variable proposed by Graham and Smith (1996) to get a more precise valuation of the tax incentive to hedge for the Canadian firms in our sample. Besides, we propose a simultaneous equations framework to control for the possible endogeneity between the debt policy and the risk management strategy. Indeed, Stulz (1996) and Leland (1998) claim that the tax advantage of financing with debt could be more important for firms who manage risk, because risk management can lead to a higher debt capacity, and consequently to more interests deductions from the taxable income. Graham and Rogers (2002) provided recently an empirical support for this hypothesis. Therefore, we should not consider the debt as an exogenous variable when studying the risk management determinants. The system we aim to estimate corresponds to two simultaneous equations with two censored dependant variables and panel data. The estimation of such system represents a very challenging task and to our knowledge no methodology exists in the literature to do so. We overcome this problem by extending the minimum distance estimator proposed by Lee (1995) to a panel dataset. Such methodology would be very useful to researchers who seek to estimate different forms of simultaneous equations with panel data. Our results suggest that financial distress costs, informational asymmetry and managerial risk aversion affect the risk management strategy even when we control for the endogenous relation between the risk management and the debt decisions. This statement does not hold for the tax and size arguments who loose their explanatory power when we endogenize the debt decision. Our evidence also suggests that firms manage risk in order to reduce their financial distress costs rather than increase their debt capacity: the effect goes in only one way, not as reported in Graham and Rogers (2002). Finally, the board of directors seem to play no active role in the decision making of the risk management policy.
while CEOs who are also chiefs of the board seem to be attracted by hedging with financial instruments, only when the debt is considered as an endogenous decision.

The remainder of the paper is structured into five sections. Section I reviews the literature and draws our main hypothesis. Section II describes our sample and the different variables we use in the analysis, and reports the results of our preliminary investigation. In section III, we report the results for the single equation model. Section IV proposes a simultaneous equations framework to endogenize the debt policy and the risk management decisions. Section V concludes the paper.

1. THE RATIONALE FOR RISK MANAGEMENT
The financial literature proposes a multitude of theories to explain why firms manage risk. Basically, we can distinguish between two classes of explanations: those based on market imperfections and those based on managerial risk aversion.

A. Market imperfections as a rationale for risk management
In the Modigliani and Miller (1958) perfect world, risk management is irrelevant because shareholders can replicate at their level any strategy adopted by the firm. However, financial markets are not perfect and firms pay great attention to the way they manage risks since it seems to affect their value and management behaviour. Several papers tried to model particular market imperfections as determinants of risk management strategies; more specifically, unobservable imperfections such as information asymmetry; and observable imperfections.

A.1. Unobservable imperfections
Stulz (1990) claims that risk management can reduce either the overinvestment or underinvestment costs resulting from the unobservability of managerial actions. The effectiveness of such policy is, in general, inversely related to the volatility of the cash flows generated by the firm. This negative relation in Stulz (1990) implies that firms will manage risk to decrease cash flow volatility because it reduces one of the costs related to managerial discretion in presence of information asymmetry for shareholders. DeMarzo and Duffie (1991) also confirm that a risk management strategy can be profitable for shareholders in presence of information asymmetry about the dividend stream. Risk management would reduce the noise in a firm’s dividend stream, which leaves shareholders better off. This is true even when hedging is costly. Breeden and Viswanathan (1998) also consider asymmetric information as a determinant of hedging. The asymmetry in their case concerns the management competence and risk management reduces the noise in the learning process concerning the managers’ capacities. In this case, risk management is a signal of the managers’ quality and superior ability. DeMarzo and Duffie (1995) show that even if the information asymmetry concerns the source and magnitude of the risks the firm faces rather than the manger’s ability, risk management benefit shareholders and increases the value of the firm.

Whether information asymmetry concerns the cash flows generated from management investment decisions (Stulz (1990)), firm dividend stream (DeMarzo and Duffie (1991)), managers’ abilities (Breeden and Viswanathan (1998)) or the magnitude and characteristics of the risks the firm faces (DeMarzo and Duffie (1995)); the more important it is, the more
attractive would be risk management for a firm since it reduces the costs associated with such asymmetry.

A.2. Observable imperfections
Several observable market imperfections are advanced in the literature to explain why firms manage risks. Among these imperfections, we note taxes, financial distress costs, and investment opportunities.

A.2.1. Taxes
The tax argument was first introduced by Smith and Stulz (1985). The argument is that in presence of a convex tax function, hedging reduces the variability of the pre-tax firm value and the firm’s tax liability because it locks the taxable earnings in a predefined level. Therefore, it will increase post tax firm value, as long as hedging benefits outweigh its costs. The tax advantage of hedging proposed by Smith and Stulz (1985) becomes more important as the tax function becomes more convex. This prediction is confirmed by results reported among others in Nance, Smith and Smithson (1993).

A.2.2. Financial distress costs
According to Smith and Stulz (1985), financial distress costs represent a possible explanation of why firms manage risk. Assuming a fixed investment policy, Smith and Stulz (1985) argue that hedging can decrease the present value of financial distress costs even if hedging is costly. Under the financial distress argument, hedging increases shareholders’ wealth because it decreases the expected value of direct bankruptcy costs and the loss of debt tax shield. One important implication in Smith and Stulz model (1985) is that, if hedging costs are proportional to the value of the firm, smaller corporation should hedge more because the reduction in financial distress costs is more important in their case.

A.2.3. Investment opportunities
Froot, Scharfstein and Stein (1993) argue that when external financing is more costly than internal financing, firms with attractive investment opportunities will adopt higher risk management levels to ensure the availability of more internally generated funds in order to realise the firm’s investment opportunities. Froot, Scharfstein and Stein (1993) present the risk management strategy as a tool to reduce the under investment problem. This is quite similar to the argument proposed in Stulz (1990) claiming that risk management could reduce either the under investment or the over investment costs, but in Froot, Scharfstein and Stein (1993), under investment results from financing constraints. Morellec and Smith (2002) also argue that when managers have control over the financial policy, their incentive to hedge increases with the firm’s investment opportunities. In their model hedging has two opposite effects on manager’s risk shifting incentive: (1) first hedging decreases the free cash flows level in the firm and therefore constraints the manager’s investment policy in the short run, (2) second hedging decreases the financial distress costs and improve the firm’s credit risk which lead to an increase in the investment level in the long run. This second effect of hedging tends to dominate the first as the number of investment opportunities increases. Consequently, manager’s incentives to hedge would be positively associated with the number of growth options available in the firm. The positive relation between the firm’s investment opportunities and risk management activities was confirmed by results reported

B. Managerial risk aversion as a rationale for risk management

Stulz (1984) and Smith and Stulz (1985) were among the first to discuss managerial risk aversion as a possible explanation of risk management. Stulz (1984) argues that managerial compensation contract, supposed to be a constant fraction of changes in the firm value, will affect considerably the hedging position taken by the firm: Managers will prefer to reduce the variance of the firm value without inducing any costs for shareholders because markets are perfect. According to Smith and Stulz (1985), a manager will hedge less as long as his expected utility is a convex function of the firm value, even if his expected utility is a concave function of his personal wealth. Though, since options are supposed to create a convex relation between the managers’ utility and firm value, we should expect managers with important holdings in options to hedge less and seek more risk than the ones with no, or small options holdings. On the other hand, compensation packages that lead to a concave function between the manager’s expected utility and the firm value will encourage managers to hedge more. Consequently, managers holding a significant fraction of the firm’s shares would search more hedging. Guay (1999) reports results confirming that options compensation significantly increases the convexity of the relation between manager’s wealth and the firm value. Also, Tufano (1996), Rajgopal and Shelvin (2002) and Rogers (2002) show that hedging level is a decreasing function of managers’ options holdings. These results seem to confirm the robustness of the Stulz (1984) and Smith and Stulz (1985) models. However, Carpenter (2000) argues that option compensation does not automatically lead to more risk seeking. Under some conditions, giving risk averse managers more options incite them to reduce the firm value volatility and thus adopt higher levels of risk management. According to Carpenter (2000), stock options create two opposing effects on managerial wealth. The first effect is that the manager’s wealth becomes more important as the volatility of the stock return increases and options payoffs become more important. This first effect should cause managers to hedge less. The second effect is that payoffs from options become less important as the stock price decreases. This should cause risk-averse managers to increase their hedging to avoid a drop in the share price. If the second effect is more important than the first one, managers will hedge more when they are paid with stock options. This conjecture is confirmed by results reported in Knopf, Nam and Thornton (2002), and explains the positive relation between option detentions and hedging reported in Géczy et al (1997) and Gay and Nam (1999).

Building on the literature reviewed above, we examine the determinants of risk management strategies for a large sample of gold mining firms in North America. We put forward two hypotheses: First, firms do hedge in order to increase their value especially through a reduction of their tax liability and financial distress costs; and hedge less in presence of hedging substitutes. The variable we construct to proxy the tax savings from hedging activities should capture any tax incentive to hedge. Second, some of the hedging is done to increase the managerial utility. Our tests will also confirm whether the board of the firm takes an active role in the risk management decision.
2. SAMPLE CONSTRUCTION AND VARIABLES

A. The delta percentages
The initial data on the delta percentages comes from Dionne and Garand (2003). They document 898 quarter-company risk management observations (the delta percentages) relative to 45 North American gold mining companies over the 1991-1998 period. We first updated their sample by including data relative to the 1999 year. The information used to calculate the delta percentages was gracefully provided by Ted Reeve, a Canadian analyst specialized in the gold mining industry. Ted Reeve published, for several years, quarterly reports containing details on hedging activities for North American gold mining firms over the future three years. Mining firms usually hedge their gold price exposure by selling forward contracts, future contracts and call options, buying put options, and contracting gold loans. The delta percentage for a given quarter is the fraction of the planned gold production that is hedged for the three future years. To obtain the delta percentage for each firm-quarter, we first have to calculate the deltas of each instrument that is used to hedge the production over the next three years. Each delta is then multiplied by the ounces of gold that are covered with the corresponding instrument to obtain what Tufano (1996) calls the delta ounces. Finally, we have to take the sum of the different delta ounces in order to obtain the delta of the hedge portfolio detained by a firm. We then calculate the delta percentage as the delta of the hedge portfolio divided by the expected gold production over the same three years that are used for the hedge variable.

B. The sample
For each firm-quarter observation, we collect data on the market value of the firm, leverage, liquidity, acquisition expenses, operating income, selling and general expenses, depreciation and amortization, book value of property, plant and equipment and sales from COMPUSTAT Quarterly. The data relative to the firms operating cash cost and exploration expenditures was hand collected from quarterly reports. Data on directors and officers shareholdings and options holdings, the percentage of shares owned by institutions, the board size and composition were hand collected from the proxy statements and annual reports. We were able to collect complete data for a sample of 506 firm-quarter observations. Some of the companies in our initial sample had to be dropped because they were acquired; filed bankruptcy or simply their management was unable to locate the proxy statements or quarterly reports for the fiscal years we requested. We lost 21 observations when collecting data from COMPUSTAT annual files to construct the tax save variable and the marginal tax rates. Our proxy for taxable income is taxable accounting earnings before extraordinary items and discounted operations. Our final sample consists of 485 quarter-company observations relative to 36 North American gold mining companies: 25 Canadian and 11 US.

Footnotes:
1 For more details concerning the construction of the delta percentage, see Tufano (1996)
2 We needed data from proxy statements and quarterly reports ranging from January 1991 to December 1999. These documents were unavailable on EDGAR (for US firms) or SEDAR (for Canadian firms) for many cases, especially in SEDAR where data is not available before January 1997. We had to contact the firms and ask them to send us their proxy statements and quarterly reports for the quarters we needed.
C. The Variables

C.1. Unobservable Imperfections: information asymmetry
As in Graham and Rogers (2002), we measure informational asymmetry by the percentage of shares held by institutions. In fact, institutions are very exigent shareholders who typically have privileged access to management information and facilitate its processing in the financial markets. Therefore, firms having high institutional ownership should suffer less from informational asymmetry and then should be less inclined to hedge.

C.2. Observable Imperfections
Taxes: According to Graham and Smith (1999), using a variable based on existing NOL or deferred income taxes to measure the tax function convexity is incorrect because it does not capture incentives resulting from such convexity. They propose a simulation procedure that measures correctly the convexity of the tax function. This approach quantifies the tax savings resulting from a decrease in the volatility of taxable income when a company uses a risk management strategy. We measure the tax function convexity using a procedure similar to the Graham and Smith (1999) approach. We expect a positive relation between this variable and the delta percentage. We calculate the tax savings resulting from a five percent reduction in the volatility in order to be consistent with empirical findings reported in Guay (1999). Unfortunately, it is impossible for us to construct the tax save variable on a quarterly basis so we calculate it on an annual basis and suppose that it is constant for the four quarters of the year. For each firm-year observation, we first collect all available data on taxable incomes from COMPUSTAT annual files for previous years, in order to calculate the drift $\mu_i$ and the volatility of the innovations on a rolling historical basis. For example, to estimate the drift and the volatility for Hecla Mining Corporation in 1996, we used data on its taxable income from 1976 to 1995 and we use data from 1976 to 1996 to estimate the drift and the volatility for 1997. Next, using the drift and volatility estimates, we generate for each US firm a normal variable $\epsilon$ with 18 realisations (15 years to take into account for carry forwards and 3 years for carry backs). In the United States, net operating loss can be carried back 2 years and forward 20 years after late 1998. However, because our sample ranges mainly from 1991 to 1998, we use the old legislation that allows firms to carry back losses for 3 years and forward for 15 years. For Canadian firms, we generate a normal variable with only 10 realisations because the Canadian legislation allows firms to carry back net operating losses for 3 years and forward for 7 years only. Then, we use the generated normal variables to simulate taxable incomes from t+1 to t+18 for US firms and from t+1 to t+10 for Canadian ones. Taxable income for firm i in year t ($TI_{it}$) is supposed to follow a random walk variable as follows:

$$\Delta TI_{it} = \mu_i + \epsilon_i$$

Next, we calculate the tax liability for each firm in each year t using the simulated future taxable incomes and historical taxable incomes for year’s t-3, t-2 and t-1. For each firm, we consider the tax plan corresponding to its home country. We then suppose a five-percentage decrease in the volatility calculated in the first step and recalculate the tax liability. The tax save variable is calculated as the difference between the tax liability paid in the full volatility case, and the tax liability paid in the reduced volatility case. We perform this procedure 1000 times for each firm in each year. The expected tax savings is then obtained.
by averaging the 1000 tax save values calculated. As in Graham and Rogers (2002), we scale the expected tax saving by the sales in the regression analysis.

As stated above, we introduce some modifications into the Graham and Smith (1999) approach. In fact, Graham and Smith (1999) treat Canadian and US firms from COMPUSTAT identically by applying the American legislation and tax code for their whole sample. We think that it is more appropriate to use for each firm the legislation of its original country. Graham and Smith (1999) also repeat the procedure 50 times only, which could be insufficient when dealing with simulations. Therefore, we repeat our simulation 1000 times.

**Financial Distress Costs:** As in Tufano (1996), we measure financial distress costs with two variables: cash cost and leverage. Cash costs will proxy the operating efficiency for a gold mining company since it measures the operating costs of producing one ounce of gold, excluding all non-cash items such as depreciation, amortisation and other financial costs. The higher is the cash cost, the more inefficient a firm is supposed to be, and the higher would be the probability that it faces a financial distress. The second variable used is leverage and will proxy the firm’s financial efficiency. The leverage is measured as the book value of the long-term debt divided by the firm’s market value. If Smith and Stulz (1985) model is consistent with what we observe in the real world, we should observe a positive relation between the delta percentage and both variables measuring the financial distress costs.

**Firm size:** We use the natural logarithm of the firm’s sales revenues to control for firm size. If the risk management costs are proportional to the firm’s size as stated in Smith and Stulz (1985), small firms should hedge more and we should obtain a negative coefficient for this variable. However, if the risk management costs are fixed, larger firms might hedge more especially if these costs are important.

**Investment Opportunities:** Our proxies of the firm’s investment opportunities are the exploration expenditures and the acquisitions expenditures both scaled by the firm’s market value. In fact, gold mining companies can decide to expand either internally by exploring new mines or externally by acquiring already existing mines. If firms use risk management to ensure internally generated funds to pursue those activities, we should observe a positive relation between the delta percentage and these two variables.

### C.3. Managerial Risk Aversion

We measure managerial risk aversion by two variables: the value of the common shares owned by directors and officers at the quarter end, and the number of options held by directors and officers\(^3\). We did not use the sensitivities of D&O option portfolio to stock return and stock return volatility (the Delta and Vega of the option portfolio) as proxies for managerial risk aversion as in Knopf, Nam and Thornton (2002), Rajgopal and Shevlin (2002), Rogers (2002) and Graham and Rogers (2002) for two reasons. The first one is the data limitation. Our sample ranges between January 1991 and December 1999. In the early years of our sample period, firms report few details about their option grants for the current year and practically no details about the options granted in the previous years. This lack of

\(^3\) Unfortunately, we were unable to get information on option detention on a quarterly basis and we just assume that the number of options owned by directors and officers is constant through the fiscal year. This hypothesis does not violate considerably the reality since firms usually wait for fiscal year end performance to determine the number of options it will grant to its directors and officers.
data makes impossible to use the Core and Guay (2002) approximation method to calculate the sensitivities for those observations and would cause an important reduction of our sample size\(^4\). Also, S&P Execucomp database reports compensation details only for US publicly firms which would oblige us to delete all the Canadian firms in our sample and get a sampling bias problem. Second, Core and Guay (2002) rely on the dividend-adjusted Black & Scholes model to estimate the sensitivities of the D&O option portfolio to stock return and stock return volatility. As reported by several papers, such model is not totally appropriate for valuation when we deal with employee stock options (ESO). In fact, as stated in Rajgopal and Shevlin (2002), the partial derivatives used to calculate the sensitivities, likely overstates the real values of the ESO risk incentive (Vega) and the ESO wealth effect (the Delta). Taking into account these reasons, we use the value of common shares owned by directors and officers, and the number of options held by directors and officers as proxies for managerial risk aversion. We are aware that those variables have their own limitations but we think they still represent acceptable proxies of managerial risk aversion.

**C.4. Other control variables**

*Alternatives to hedging:* Derivatives and gold loans are not the only tools firms can employ to manage gold price risk. Indeed, instead of hedging price risk with financial instruments, gold mining firms can simply decide to support themselves the losses caused by an adverse movement in the gold market. Usually, firms who decide to retain their own losses form liquidity cushions intended to facilitate such retention. Consequently, the existence of liquidity cushions should be negatively associated with the level of risk management through financial instruments. Nance, Smith and Smithson (1993) and Tufano (1996) reported empirical results that support such hypothesis. We include in the regression the quick ratio to proxy the firm’s liquidity and we expect a negative coefficient for this variable. The quick ratio is defined as the value of the cash on hand, short term investments and clients’ accounts divided by the short term liabilities.

*Constraints on managerial discretion:* In some cases, managers hedge more, not in order to decrease the firm’s financial distress costs, tax liability or underinvestment costs but simply to increase their own utility. This situation has a higher probability to occur when managers have greater discretionary power to make sub optimal decisions from a shareholder perspective. Outside directors and the separation between the CEO and the chief of the board responsibilities are usually adopted as mechanisms to limit the managerial discretion. These mechanisms are supposed to lead to an optimal level of hedging. In this sense, Borokhovich et al (2001) report a positive relation between the number of outside directors in the board and the quantity of interest rate hedging held by the firm. We use two variables as proxies for constraints on managerial discretion: the number of outside directors as a percentage of the board size and a dummy variable equal one if the CEO is also the chief of the board. A director is defined as an outsider if he is independent of the firm’s management and free from any interest or relationship that could be perceived to affect his ability to act with a view to the best interests of the firm, other than interests arising from shareholdings. If the coefficients of the two variables proxying constraint on managerial

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\(^4\) Using the sensitivities of D&O option portfolio to stock return and stock return volatility as proxies for managerial risk aversion would lead to a sample size under 100 observations and cause statistical problems related to the small sample size.
discretion are respectively positive and negative, the evidence would be consistent with corporate hedge in the interest of shareholders. Finally, we include a dummy variable equal to one if the firm is US to control for the firm’s nationality.

D. Descriptive statistics
Table I reports descriptive statistics for the variables used in the regression analysis. Most firms composing our sample have delta percentages comprising between 0 and 50%, which indicates that these firms use derivative hedging mainly to reduce gold price risk rather than to speculate. We break the sample into three groups according to the level of the risk management adopted by the firm. The first group uses no risk management (delta percentage equal to 0%), the second group uses moderately risk management (delta percentage between 0% and 50%) and the third group uses extensively risk management (more than 50%). The last four columns in Table I report the p-values corresponding to the t-test of the differences in means between the groups (column 10 and 11), and the significance level of the non parametric Wilcoxon rank sum test for differences between the median of the groups (12 and 13). The p-values reported in column (10) of Table I, show that firms using an extensive level of risk management are very different from those having no risk management activities. Indeed, the firms in the extensive level group have higher financial distress costs measured both by leverage and cash cost, carry less liquidity and have lower institutional shareholding than those using no risk management. They are also twice larger in terms of sales revenues and three times larger in terms of market value. Also, the managers of the extensive risk management group have greater equity stake value in the firm and hold more options. This is possibly due to the larger size of these firms. In fact, larger firms are more likely to suffer from agency costs resulting from interest conflicts between managers and shareholders, because their activities are more complex to monitor. Therefore, larger firms have a greater incentive to offer their managers compensation packages containing stocks and options in order to align their interests with the shareholders’ ones. Another possible explanation is that larger firms are more difficult to manage and consequently their managers deserve higher compensations. Interestingly, despite their large size, the firms in the extensive group, compared to the no risk management group, do not seem to spend significantly more money in acquisition and exploration activities. The Wilcoxon rank sum test results reported in column (12) confirm the conclusions drawn for the financial distress costs, liquidity, institutional shareholding and managerial shareholding and options detentions. However, the median differences between the two variables measuring size are not significant suggesting that an important risk management program is not exclusive to large firms.

An inspection of the second column of p-values reported in Table I (column 11) suggest that firms using extensive levels of risk management have higher cash cost, are larger in terms of market value and sales revenues and carry less liquidity than the firms using moderately risk management. As predicted, the managers of the firms in the extensive risk management group have greater equity stake value in the firm, less outside directors in their board and less institutional shareholding. Interestingly, the number of options held by the managers in the extensive group is more important which would be in favour of the prediction of Carpenter’s (2000) model that managers holding more options do not necessarily hedge less. The results of the non parametric Wilcoxon rank sum test reported
in column (13) suggest that firms managing extensively risk might be less efficient at the operational level (their cash cost is higher), explore more and carry less liquidity (as predicted). The conclusion concerning the manager’s stake value and options holdings, the composition of the board and the institutional shareholding remain unchanged. One interesting result shown with this test is that firms having a greater tax advantage to hedge do not necessarily hedge more.

(Insert Table I)

Overall, the results reported in Table I suggest that the firms in the three groups present different characteristics. The risk management level adopted by a firm seems to be affected by the managerial risk aversion measured both by the value of common shares and the number of options held by managers. The existence of liquidity cushions seems also to lead to less risk management by financial instruments. Finally, some financial characteristics seem to affect the risk management decision such as size and financial distress costs. However, the results reported in Table I have a univariate aspect and cannot be generalised without a multivariate analysis. The following section will provide such analysis.

3. MULTIVARIATE ANALYSIS

Empirical evidence reported in Tufano (1996) shows little support for financial theories that view firm value maximization as a rationale for risk management. However, his evidence supports theories that link managerial risk aversion to the risk management decision. In this section, we report the regression results for a single equation model. As in Tufano (1996), we investigate the determinants of the risk management decision for a dataset of North American gold mining firms. However, we employ quarterly rather than annual data over a longer period of time (ten years instead of three). Using quarterly data allows a greater number of observations and results that suffer less from problems related to small sample size. Also, such data makes possible to capture more adequately the dynamic aspect of the risk management decision.

A. Regression analysis with quarterly data

Results of the regression analysis with a single equation model are reported in Table II. The dependant variable in the regressions is the delta percentage measured at the quarter end and all the independent variables are measured one quarter prior to the one in which the risk management data is available. The delta percentage is a variable that is censored at zero and cannot be estimated by a simple OLS. Therefore, we use a Tobit model to account for such censoring. Moreover, our sample consists of panel data and we had to choose between a random effect and a fixed effect specification. In this case, we opted for a random firm effect model because the fixed effect specification suffers from the incidental parameters problem described by Neyman and Scott (1948). Indeed, Greene (2002) shows that the incidental parameters problem does not lead to biased estimates of the slope in the case of a Tobit specification, but does cause a downward bias in the estimated standard deviations. Such problem might lead to erroneous conclusions concerning the statistical significance of the variables used in the regressions. Since we are more interested in testing the significance rather than the economic impact of each theory, we opted for the random firm
effect Tobit specification. We also report results for a Tobit model in order to gauge the impact of the estimation method and compare our results with Tufano (1996)\(^5\).

The results obtained with a Tobit model are reported in column A of Table II. Both variables used as a proxy for managerial risk aversion have the predicted sign and are respectively significant at the five and ten percent. This result confirms Tufano (1996) conclusion that managerial risk aversion is an important determinant of the risk management decision, and Smith and Stulz’s (1985) prediction that, paying managers with shares push them to manage more risks while paying them with options lead them to seek more risk. However, according to the reported results, the only argument relative to the maximisation of the firm value that affects the risk management decision is the reduction of the financial distress costs. Thus, firms do not manage risk in order to reduce their tax liability nor to ensure more internally generated cash flows for investment purposes. Size seems also to have no effect on such decision. Moreover, according to the coefficients and p-values reported in column A of table II, firms carrying liquidity cushions should decrease their hedging activities with financial instruments while those suffering from important informational asymmetry manage more the risk they face.

Overall, the results reported in column A support Tufano (1996) conclusions and suggest that an important part of the risk management activities is adopted by the firm to maximise the manager’s utility.

Column B of Table II reports results for the same model obtained with a random firm effect Tobit specification. Such specification is more adapted to the dataset we have. Unlike the results reported in Column A of Table II, the variables proxying the tax advantage of hedging and size are significant at the ten and five percent level respectively, suggesting that firms manage risk in order to decrease their tax liability, and are more willing to do so when they are large. The positive coefficient observed for the natural logarithm of the firm’s sales confirms Haushalter (2000) findings that larger firms hedge more. The important costs of risk management can explain why larger firms hedge more. Recall that risk management requires the hiring of financially well-trained persons to implement strategies and the manipulation of sophisticated financial instruments. These activities are usually very expensive and small firms might not afford them. In a consistent fashion, the variables relative to the managerial risk aversion have the predicted sign and are both significant at the five percent level as in Tufano (1996). This result confirms that managerial risk aversion affects considerably the risk management decision. The institutional shareholding variable has a negative and significant coefficient at the five percent level confirming that reducing information asymmetry costs is also a motive for managing risk. The results reported in column A of Table II also are in favour of firms hedging less with financial instruments in presence of liquidity cushions.

Both variables used as proxies for constraint on managerial discretion have an insignificant coefficient. These results suggest that combining the CEO and the chief of the board positions has no effect on the risk management activity in a firm and also contradict

---

\(^5\) We also tried to run regressions with a random effect Tobit model using only the end-of-the-year hedge ratios in annual tests. Unfortunately, given the small sample size in this case, the random effect model does not converge.
Borokhovich et al (2001) conclusion that the board of directors play an active role in the decision making of such policy. These findings are very interesting especially with the increasing debate concerning the effectiveness of corporate governance mechanisms to solve the agency problem in public firms. Thus far, we reported evidence showing that risk management increases the firm’s value through different mechanisms. Consequently, one will expect firms with more efficient boards (boards with many outside directors) to have higher level of risk management because it is an advantageous activity for shareholders. The insignificant coefficient we report for the board variable suggest that outside directors are not acting in the benefit of the shareholders because they do not try to increase the firm’s value through risk management. A plausible explanation of the passive role played by the outside directors is that they have insufficient background to understand the risk management activities in the firm and have less information about such policy than inside directors. Consequently, the presence of outside directors in the board would not affect the risk management policy, not because outside directors do not want to act in the benefit of the shareholders but because they are simply unable to understand this complicated activity. This argument is supported by Buckley and Van Der Nat (2003) findings who report disturbing level of ignorance concerning risk management activities among outside directors. Finally, the two variable proxying the financial distress costs have a positive and significant coefficient at the five percent level suggesting that firms manage risk to reduce costs resulting from operational and financial efficiencies.

Roughly speaking, the results presented in column B show that, when we take into account the panel aspect of the data, some variables relative to the maximisation of the firm’s value argument become statistically significant. Unlike Tufano (1996), our results suggest that managers hedge, not only to maximise their utility, but also to maximise the value of the firm by reducing the financial distress costs, the firm’s tax liability and the costs caused by informational asymmetry. Also the risk management activity in a firm seems to be positively related to its size confirming the cost argument already mentioned by Stulz (1996). Our results also support Dionne and Garand (2003) conclusion concerning the relevance of the firm value maximisation arguments in explaining the risk management activity.

(Insert Table II)

4. THE ENDOGENOUS RELATION BETWEEN RISK MANAGEMENT DECISION AND DEBT POLICY

Thus far, we looked at, whether risk management can be explained in part by the financial distress argument. Our model treats financial distress, measured by leverage, as an exogenous variable that is not affected by the risk management level in a firm. However, Froot, Scharfstein and Stein (1993) argue that (1) if financial distress is costly and (2) if debt provides a fiscal advantage or a reduction in agency costs, risk management can be used to increase the debt capacity. The argument that risk management affects the debt policy and can increase the debt capacity can also be found in Stulz (1996) and Leland (1998). According to Graham and Rogers (2002), this increase in debt capacity caused by higher risk management level will provide an additional tax incentive to hedge. In fact, a higher debt level means that the firm can deduct more interest payment from its taxable income.
income, which gives her a higher after tax value. Hence, the reduction of expected tax liability in presence of a convex tax function is not the only tax motive for firms to hedge. Consequently, the relation between risk management and debt can go both ways and it would be inappropriate to use a single equation model to capture it. To take into account the endogenous relation between risk management and debt policy, we perform our regressions using a simultaneous equations model.

A. The model

Our model consists of a two simultaneous equations system: one equation for the risk management decision and one equation for the debt policy decision. The equation for the risk management contains the same explanatory variables than in the previous section. The dependant variable is the delta percentage measured at the quarter end.

The dependant variable in the debt specification is leverage measured as the book value of long-term debt divided by the firm’s market value. We incorporate in the debt equation the delta percentage as an independent variable. A positive and significant coefficient will confirm Graham and Rogers (2002) findings and indicate that firms hedge in order to increase their debt capacity. The other independent variables are standard in the literature (e.g., Titman and Wessels (1988)). For example, we use the book value of property, plant and equipment divided by the book value of total assets as a proxy for the firm’s collateral value of assets, on the grounds that firms with more tangible assets can use them as collateral to get more debt. Hence, we expect a positive coefficient for this variable. Our proxy for the non-debt tax shield is depreciation and amortisation divided by the book value of total assets. We expect a negative coefficient for this variable because tax deductions provided by depreciation and amortisation can be substitutes to the tax advantage generated by debt. The third variable used in the debt equation is the marginal tax rate (MTR)\(^6\). We expect a positive coefficient for this variable because a higher MTR will lead to a higher tax advantage to financing with debt. We also include in the debt equation the ratios of exploration and acquisitions expenditures to the firm’s market value as proxies for the firm’s growth opportunities. We expect a negative coefficient for both variables. According to Titman and Wessels (1988), growth opportunities cannot be collateralised nor generate tax deductions, causing firms with important growth opportunities to carry less debt in their capital structure. The variable we incorporate as a proxy for the firm uniqueness is the selling, general and administrative expenses divided by the net sales. We expect a negative sign for this variable. Our debt specification contains also a proxy for size: the natural logarithm of the firm’s sales revenues. Big firms are supposed to be more diversified and therefore have lower probability to suffer from financial distress. This argument suggests that bigger firms should be more leveraged. Furthermore, larger firms can benefit from economies of scale and issue long-term debt at lower costs than smaller firms. Larger firms should then carry more long-term debt than smaller ones. We also control for the firm’s profitability because profitable firms generate more internal funds and are supposed to need

\(^6\) Graham (1996) defines the marginal tax rate as the expected value of additional taxes paid on an additional dollar of income earned today. We construct the marginal tax rates for the firms in our sample with a procedure similar to the one we used for the tax save variable. In this case, we do not reduce volatility by 5 percent to calculate the new tax bill, we just add 1 dollar to the taxable income of year \(t\) for which we want to compute the MTR, and then we calculate the new tax bill. The MTR is defined as the difference between the new and the old tax bill.
less external financing by debt or equity. Our proxy for profitability is the firm’s operating income divided by the value of its sales. We expect a negative coefficient for this variable. We also include the volatility of the percentage change in the operating income of the firm in the debt specification. This variable is used as a proxy for the firm’s operating risk and we expect a negative coefficient for it. Firms with a high operating risk are supposed to carry less debt in order to lower their financial risk and keep their total risk at a reasonable level. Finally, we include a dummy variable in the debt equation to control for the firm’s nationality.

The estimation of our system presents some econometric challenges. In fact, the system consists of two simultaneous equations with two limited dependant variables. Also, our sample consists of panel data. Unfortunately, we were unable to find in the literature an estimation procedure for a system similar to ours. Discussion with some econometricians suggested that the minimum distance estimation technique (MDE hereafter) originally proposed by Amemiya (1978) could be a suitable alternative. The advantage of such method is that it provides unbiased and consistent estimates of the structural form coefficients when the error terms in the equations might be correlated. Lee (1995) applies the minimum distance estimator to a system of three simultaneous equations with respectively a censored, a dichotomous and a regular dependant variable. However, his procedure can only be applied to cross sectional data. We followed Lee’s reasoning to develop our methodology and get consistent estimates of the coefficients in the two equations of our system. Details of our methodology are presented in the next section.

B. Methodology

The system structural form (SF) can be written as:

\[
\begin{align*}
    y_{1it} &= \alpha_{12} y^*_{1it} + X^*_{1it} \beta_1 + u_{1i} + e_{1it} \\
    y_{2it} &= \alpha_{21} y^*_{2it} + X^*_{2it} \beta_2 + u_{2i} + e_{2it}
\end{align*}
\]

Where \(y_{1it}^*\) and \(y_{2it}^*\) are respectively the risk management level and the long-term debt level targeted by the firm, \(X_{1it}\) and \(X_{2it}\) are \((k_1 \times 1)\) and \((k_2 \times 1)\) vectors of exogenous variables (including a constant term) supposed to affect respectively the risk management and the debt decisions. The terms \(u\) and \(e\) correspond respectively to the random firm effect and error components. \(\alpha\)’s and \(\beta\)’s are parameters to be estimated. In this case, only maximum \((y_{1it}^*, 0)\), maximum \((y_{2it}^*, 0)\), \(X_{1it}\) and \(X_{2it}\) are observed.

Hypothesis:
1- \((u_{1i}, u_{2i})\) are jointly normally distributed with zero mean;
2- \((e_{1it}, e_{2it})\) are jointly normally distributed with zero mean;
3- \(\alpha_{12} \times \alpha_{21} \neq 1\);
The system reduced form (RF) can be derived as:

\[
\begin{aligned}
    y^*_{1it} &= X'_i\eta_1 + l_{1i} + \lambda_{1it} \quad (3) \\
    y^*_{2it} &= X'_i\eta_2 + l_{2i} + \lambda_{2it} \quad (4)
\end{aligned}
\]

Where \( X'_i \) is a vector containing all the exogenous variables in the system such as \( X'_i = [X'_1, X'_2] \), \( \eta_1 \) and \( \eta_2 \) are the reduced form parameters vectors, \( l_{1i} \) and \( l_{2i} \) are the reduced form random firm effects; and \( \lambda_{1it} \) and \( \lambda_{2it} \) are the error terms. Let’s define \( \Delta = 1 - \alpha_{12} \times \alpha_{21} \). We can show that:

\[
\begin{aligned}
    \eta_1 &= \begin{bmatrix} \beta_1 / \Delta \\ \beta_2 \alpha_{12} / \Delta \end{bmatrix}, \\
    \eta_2 &= \begin{bmatrix} \beta_1 a / \Delta \\ \beta_2 a \alpha_{12} / \Delta \end{bmatrix}, \quad \text{and}
\end{aligned}
\]

The first step of the MDE procedure consists in estimating the reduced form parameters. In our case, each equation in the reduced form corresponds to a random firm effect Tobit model. We estimate each equation by Maximum Likelihood. This step provides us with estimates of etas, thetas and sigmas. Next, the relationships between the reduced form and the structural form parameters are used to formulate restrictions on the structural form parameters. Comparing the system SF and RF, we have:

\[
\begin{aligned}
    \eta_1 &= \alpha_{12} \eta_2 + J_1 \beta_1 \quad (5) \\
    \eta_2 &= \alpha_{21} \eta_1 + J_2 \beta_2 \quad (6)
\end{aligned}
\]

Where \( J_1 \) and \( J_2 \) are the exclusion matrices constructed such as: \( X'_i J_1 = X'_{1it} \) and \( X'_i J_2 = X'_{2it} \). These restrictions are used to recover consistent but inefficient estimates of the structural form parameters. To do so, we replace \( \eta_1 \) and \( \eta_2 \) by \( \tilde{\eta}_1 \) and \( \tilde{\eta}_2 \) obtained from step one, add an error term \( \omega_k \) (k=1,2) to equations (5) and (6) and then apply OLS to each equation. The last step of the procedure consists in calculating a variance-covariance matrix based upon the effective scores for ETAs from each reduced form equation, and use it as a weighting matrix to get efficient estimates of the structural form parameters. Lee (1995) defines the effective score for ETAs as the residual of regressing the score for the ETA on the score of the error term standard deviation. In our case, the score for the error term standard deviation will be a matrix with two elements: one is corresponding to the score for theta (the standard deviation of the random firm effect) and one is corresponding to the score for sigma (the standard deviation of the error term). The effective score
calculation requires the computation of the log likelihood derivatives w.r.t. \( \eta, \theta \) and \( \sigma \) which could be a very long and difficult task to achieve. To overcome this problem, we first construct the log likelihood function corresponding to a random firm effect Tobit model and then evaluate the derivatives numerically using the derivative definition. Numerical integration is done using the Gauss-Hermite quadrature rule. The log likelihood function of a random firm effect Tobit model is presented in the appendix. The effective scores for ETAs are then multiplied by the inverted information matrix and used, with the inefficient estimates of the structural form parameters obtained from the previous step, as inputs to calculate the variance covariance matrix. Finally we estimate the whole system by a procedure analogous to a SURE method.

C. Simultaneous equation system results

Table III reports the results for the simultaneous equation system. Column (A) contains the estimated coefficients for the delta percentage equation. Interestingly, both leverage and cash cost have a positive and significant coefficient at the five percent level suggesting that, even when we control for the endogenous relation between debt and risk management, firms hedge in order to reduce their financial distress costs. The managerial risk aversion argument proposed by Smith and Stulz (1985) is also supported since the coefficients of the two variables used to proxy it have the predicted sign and are significant at the five percent level. Besides, the results in Table III suggest that firms manage risk in order to reduce the costs of informational asymmetry. Risk management activities seem also to be more important in firms where the CEO is also the chief of the board. This last finding is consistent with the argument that risk management lead to an increase in the manager’s utility. As in Tufano (1996), one of the variables proxying the firm’s investment opportunities (acquisition in our case) is negatively related to risk management. This finding is apparently counterintuitive and contradicts the hypothesis that firms set up risk management programs to ensure more internally generated funds for investment purposes. However, this result is not surprising if we take into account the negative relation that might exist between the acquisition activities and the gold price. Indeed, gold mining firms would find less profitable to acquire new mines when the price of gold is not high enough to cover the acquisition costs. Therefore, acquisition expenditures would be less important in periods of bearish gold market while firms would be more tempted to hedge in this kind of market. Unfortunately, the weak significance level of the acquisition variable and the insignificant coefficient reported for the exploration variable provide little support for this argument. Also, when we endogenize the debt decision, the board of directors has no active role in setting the risk management policy, and the tax and size arguments lose their explanatory power. Of particular interest, the coefficient of the quick ratio is positive and significant suggesting that risk management with financial instruments and liquidity cushions are not necessarily substitutes. Finally, risk management seems to be more popular among US than Canadian firms. This might be caused by the greater liquidity of the gold derivatives market in the US\(^7\). Indeed, it is obvious that corporate hedging would

\(^7\) For example, according to the triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity published by the BIS, the total notional value of gold derivatives outstanding in Canada as of March 1995 is 4.6 billions of USD while the correspondent amount for the US is 34.1 billions of USD. Unfortunately, the figures for the commodity derivatives were not available in the 1998 survey. Instead, we report the average daily turnover reported for the OTC derivatives market as of April 1998: 33.6 billions of USD for Canada and 293.8 billions of USD for the US.
be more important in liquid markets with a great choice of instruments and a lower cost of hedging.

(Insert Table III)

The estimated coefficients for the debt equation are shown in column B of Table III. First, the coefficient of the delta percentage is positive but not significant indicating that firms do not necessarily hedge to increase their debt capacity as reported in Graham and Rogers (2002). In comparison with the results from the risk management equation, it seems that the relation between debt and risk management goes mainly in the direction of firms hedging in order to decrease the financial distress costs caused by leverage, rather than firms managing risk in order to increase their debt capacity. Second, the debt level is negatively related to the firm’s uniqueness supporting the hypothesis that unique firms are more difficult to evaluate and consequently are less able to get debt financing. Also, the coefficient obtained for the firm’s operating income suggests that firm’s profitability does not automatically lead her to reduce its financing with debt. Indeed, a firm can increase its debt level even if it has important funds generated from its operations because of the several advantages provided by this source of financing i.e. the tax advantage, the reduction of agency costs and the additional control imposed to managers…etc. This situation has a greater probability of taking place when the firm carries a low leverage, which is the case in our sample. The results also show that debt is positively related to the firm’s exploration expenditures, while the book value of property, plant and equipment coefficient is not significant. This might indicate that financial markets reply more on the cash flows that exploration activities can bring rather than physical assets, when lending money to gold mining firms. Also, the debt level in gold mining firms seems to be positively related to the riskiness of their operational activities. Finally, the results suggest that US firms are more levered than their Canadian counterparts.

Overall, the results presented in this section show that even when we control for the endogenous relation between the risk management and the debt decisions, firms hedge in order to reduce their financial distress, informational asymmetry costs, and increase their manager’s utility. Unfortunately, the tax and size arguments loose their explanatory power. Also, when we endogenize the debt decision, the board of directors has no active role in the risk management decision while having the CEO and the chief of the board positions filled by the same person does lead to a higher risk management level. Furthermore, our evidence does not support the Graham and Rogers (2002) findings that risk management increases the firm’s debt capacity.

5. CONCLUSION
This paper investigates the risk management policy determinants, and complements Tufano (1996) and Dionne and Garand (2003) work. We construct a database that contains detailed quarterly information on risk management operations, financial and managerial characteristics for a sample of 36 North American gold mining firms over a ten years period. We also construct a variable based on the simulation procedure proposed by Graham and Smith (1999) that captures adequately the tax incentive to hedge for US and Canadian firms. In fact, Graham and Smith (1999) apply the American fiscal code for both US and Canadian firms in COMPUSTAT, which would provide inadequate estimates of the
tax incentive to hedge for Canadian firms. We overcome this problem by constructing for each firm a tax save variable that uses the legislation of its home country.

When the risk management policy is considered as an isolated decision, we provide evidence confirming Tufano’s conclusion that managerial risk aversion is an important determinant of the risk management strategy. However, our evidence also shows that the financial distress costs, the information asymmetry costs, size and taxes are important determinants of the decision to hedge. Unlike Tufano (1996), our findings suggest that risk management is an activity that not only maximises the managerial utility but also the firm’s value as stated in Dionne and Garand (2003). Unfortunately, the hedging to finance investment opportunities motive seem to be an irrelevant explanation. The reported results also support the argument proposed by Stulz (1996) alleging that risk management is an expensive activity that small firms might not afford. Interestingly, the composition of the board of directors seem to have no impact on the decision to hedge as well as the non separation between the CEO and the chief of the board positions.

In a second step, we control for the endogenous aspect of the relation between the risk management and the debt policy decisions. To do so, we use a simultaneous equations system framework and extend the minimum distance estimator proposed by Lee (1995) to estimate it. Our conclusions remain unchanged for the information asymmetry, financial distress and managerial risk aversion arguments. Unfortunately, when we endogenize the debt decision, taxes and size no longer constitute motives for the firm to hedge, and the non separation between the CEO and the chief of the board positions seem to have an impact on the setting of the risk management policy. An important implication of our empirical evidence is that firms do not use hedging to increase their debt capacity as stated in Graham and Rogers (2002) but mainly to reduce their financial distress costs.

A possible extension of the following paper would be to endogenize also the number of options held by D&O. In fact, in the different models specified in this paper, the number of options held by D&O is supposed to be an exogenous variable that is unaffected by, neither the risk management nor the debt decision. This assumption does not necessary reflect the reality and it would be interesting to see what happens when these three decisions are modeled simultaneously.
This Table reports summary descriptive statistics (mean, median and standard deviation) of the variables used in the regression analysis. The sample includes 494 North American gold mining companies and is segmented according to the risk management level adopted by the firm. The first group uses no risk management, the second group uses moderately risk management and the third group uses extensively risk management. The last four columns report p-values corresponding to the t-test of the differences of means between the groups and the significance level of the non parametric Wilcoxon rank sum test. The significant values at the 95% level are in bold. All independent variables are measured one quarter prior to the quarter in which the risk management information is available. In the Table, delta % is the fraction of the gold production that is hedged for the three future years; Tax save is the fiscal benefit from reducing the firm earnings volatility by five percent, scaled by the firm sales revenues; Leverage is the book value of the long term debt divided by the firm’s market value; Cash cost is the operating cost of producing an ounce of gold, excluding all non cash items such as depreciation, amortisation and other financial costs; Sales are the firm’s sales at the end of the quarter; VM is the firm’s market value defined as the number of common shares multiplied by their price at the end of quarter plus the book value of debt; Exploration and acquisition are respectively the exploration and acquisition expenditures during the quarter both scaled by the firm’s market value; the quick ratio is the value of the cash on hand, short term investments and clients accounts divided by the short term liabilities; Institutional shareholding is the percentage of shares held by institutions; D&O CS Value is the value of the common shares owned by the firm’s directors and officers and is calculated by multiplying the number of CS they hold by the share price at the quarter end; D&O nber of options is the number of options held by directors and officers at the quarter end; % of outsider is the number of outside directors divided by the board size.

<table>
<thead>
<tr>
<th>Delta =0%</th>
<th>Delta between 0-50%</th>
<th>Delta&gt; 50% Extensive (3)</th>
<th>p-values of differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None (1)</td>
<td>Moderate (2)</td>
<td>Extensive (3)</td>
</tr>
<tr>
<td>Delta %</td>
<td>mean</td>
<td>Std dev</td>
<td>med</td>
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<tr>
<td>Tax save</td>
<td>0.171</td>
<td>0.229</td>
<td>0.070</td>
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<tr>
<td>Leverage</td>
<td>0.088</td>
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<tr>
<td>Cash cost ($US/ oz)</td>
<td>232.5</td>
<td>30.5</td>
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<tr>
<td>Sales ($US, millions)</td>
<td>41.85</td>
<td>75.7</td>
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<tr>
<td>VM ($US, millions)</td>
<td>790</td>
<td>1200</td>
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<tr>
<td>Acquisition</td>
<td>0.002</td>
<td>0.014</td>
<td>0</td>
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<tr>
<td>Exploration</td>
<td>0.003</td>
<td>0.003</td>
<td>0.002</td>
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<tr>
<td>Quick ratio</td>
<td>4.547</td>
<td>3.818</td>
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<tr>
<td>Institutional shareholding</td>
<td>0.284</td>
<td>0.298</td>
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</tr>
<tr>
<td>D&amp;O CS Value ($US, millions)</td>
<td>3.463</td>
<td>5.288</td>
<td>0.947</td>
</tr>
<tr>
<td>D&amp;O nber of options (millions)</td>
<td>0.436</td>
<td>0.520</td>
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<td>% of outsider in the board</td>
<td>0.670</td>
<td>0.157</td>
<td>0.667</td>
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<tr>
<td>Number of observations</td>
<td>88</td>
<td>314</td>
<td>92</td>
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Table II: REGRESSIONS WITH QUARTERLY DATA
This Table reports the results for a random firm effect Tobit model estimation of the whole sample. The dependent variable in the regression is the delta percentage defined as the fraction of the gold production that is hedged for the three future years. The delta% is measured at the quarter end. The independent variables are measured one quarter prior to the one in which the risk management data is available. In the Table, Tax save is the fiscal benefit from reducing the firm’s earnings volatility by five percent, scaled by the firm sales revenues; Leverage is the book value of the long term debt divided by the firm’s market value; Cash cost is the operating cost of producing an ounce of gold, excluding all non cash items such as depreciation, amortisation and other financial costs; Exploration and Acquisition are respectively the exploration and acquisition expenditures during the quarter both scaled by the firm’s market value at the quarter end; The quick ratio is the value of the cash on hand, short term investments and clients accounts divided by the short term liabilities; Institutional shareholding is the percentage of shares held by institutions; D&O CS Value is the number of the common shares owned by directors and officers multiplied by the share price at the quarter end; D&O nber of options is the number of options held by directors and officers at the quarter end; % of outsider is the number of outside directors divided by the board size. Dummy COB is a dummy variable equal to one if the CEO is also the chief of the board and 0 otherwise; Dummy US is a dummy variable equal to one if the firm is US and 0 otherwise. The significant values at the 95% level are in bold, those at the 90% marked with an asterisk.

<table>
<thead>
<tr>
<th></th>
<th>Tobit specification (A)</th>
<th>Random effect Tobit specification(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slope</td>
<td>p-value</td>
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<tr>
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<td>Tax save</td>
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<td>Leverage</td>
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<td>Cash cost</td>
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<tr>
<td>Ln (sales)</td>
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<td>0.374</td>
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<td>Exploration</td>
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<td>0.210</td>
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<td>Quick ratio</td>
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<tr>
<td>Institutional shareholding</td>
<td>-0.1257</td>
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<tr>
<td>D&amp;O CS Value</td>
<td>0.0032</td>
<td>0.000</td>
</tr>
<tr>
<td>D&amp;O nber of options</td>
<td>-0.0175*</td>
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</tr>
<tr>
<td>% of outsider</td>
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<td>0.745</td>
</tr>
<tr>
<td>Dummy COB</td>
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<td>0.369</td>
</tr>
<tr>
<td>Dummy US</td>
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<tr>
<td>Sigma_u, random effect</td>
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<td>0.009</td>
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<tr>
<td>Sigma_e</td>
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<tr>
<td>Log likelihood</td>
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<td>12.6552</td>
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<tr>
<td>Number of observations</td>
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<tr>
<td>Uncensored observations</td>
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Table III: RESULTS FOR THE SIMULTANEOUS EQUATION SYSTEM

This Table reports the results of the estimation with the minimum distance method of the simultaneous equations system. The first equation in the system models the risk management decision in the firm, and the second equation models the debt decision. In this case, debt and hedging decisions are supposed to be taken in the same time, at the quarter end. The dependent variables in the two equations are respectively the delta % and the firm’s leverage. The independent variables are measured one quarter prior to the one in which the risk management and debt data is available. In this Table, delta % is the fraction of the gold production that is hedged for the three future years; Tax save is the fiscal benefit from reducing the firm earnings volatility by five percent, scaled by the firm sales revenues; Leverage is the book value of the long term debt divided by the firm’s market value; Cash cost is the operating cost of producing an ounce of gold, excluding all non cash items such as depreciation, amortisation and other financial costs; Ln (sales) is the natural logarithm of the firm sales during the quarter; Exploration and Acquisition are respectively the exploration and acquisition expenditures during the quarter scaled by the firm’s market value at the quarter end; The quick ratio is the value of the cash on hand, short term investments and clients accounts divided by the short term liabilities; Institutional shareholding is the percentage of shares held by institutions; D&O CS Value is the number of the common shares owned by directors and officers multiplied by the share price at the quarter end; D&O nber of options is the number of options held by directors and officers at the quarter end; Dummy US is a dummy variable equal to one if the firm is US and 0 otherwise; % of outsider is the number of outside directors divided by the board size; Dummy COB is a dummy variable equal to one if the firm’s CEO is also the chief of the board; BV of pp&eq is the book value of property, plant and equipment scaled by the book value of total assets; Dep&Amt is depreciation and amortisation during the quarter scaled by the book value of total assets at the quarter end; MTR is the simulated marginal tax rate; Sgl&Adm is the Selling, general and administrative expenses during the quarter divided by the net sales of the firm during the same quarter; Operating income is the Operating income during the quarter scaled by the firm sales; Volatility of % change in OI is the volatility of the percentage change in the quarterly operating income. Exploration was multiplied by 1000 to fit in the software. The significant values at the 95% level are in bold.

<table>
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<tr>
<th></th>
<th>RM equation(A)</th>
<th>Debt equation(B)</th>
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<tr>
<td></td>
<td>Slope</td>
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<td>Exploration</td>
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<td>D&amp;O nber of options</td>
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<td>% of outsider</td>
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<td>Operating income</td>
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<td>Sgl&amp;Adm</td>
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<td>Dep &amp; Amt</td>
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<td>BV of pp&amp;eq</td>
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<td>MTR</td>
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<td>Volatility of % change in OI</td>
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</table>
APPENDIX

The random firm effect Tobit model can be written as:

\[
y_{it} = y_{it}^* \text{ if } y_{it}^* > 0 \text{ where } y_{it}^* = X_{it}'\eta + l_i + \lambda_{it} \\
y_{it} = 0 \text{ Otherwise } \quad (A1)
\]

Where \( y_{it} \) is the dependent variable censored at zero, \( X_{it} \) is a \((k \times 1)\) matrix of exogenous variables (including a constant term). The terms \( l \) and \( \lambda \) correspond respectively to the random firm effect and error terms. \( \eta \)'s are parameters to be estimated. We assume that \( \lambda_{it} \sim N(0,\sigma^2) \) and \( l_i \sim N(0,\theta^2) \).

\[
P[y_{it} = 0] = P[y_{it}^* \leq 0] = P[X_{it}'\eta + l_i + \lambda_{it} \leq 0] = P\left[\frac{-X_{it}'\eta - l_i}{\sigma} \leq \frac{-X_{it}'\eta - l_i}{\sigma}\right] \text{ where } \Phi \text{ is the normal cdf.}
\]

\[
P[y_{it} = y_{it}^*] = P[y_{it} = X_{it}'\eta + l_i + \lambda_{it}] = P[\lambda_{it} = y_{it} - X_{it}'\eta - l_i] = P\left[\frac{\lambda_{it}}{\sigma} = \frac{y_{it} - X_{it}'\eta - l_i}{\sigma}\right] = \phi\left[\frac{y_{it} - X_{it}'\eta - l_i}{\sigma}\right] \times \frac{1}{\sigma} \text{ where } \phi \text{ is the normal pdf.}
\]

Let’s define \( d_{it} = 1 \text{ if } y_{it} = y_{it}^* \text{ and } d_{it} = 0 \text{ if } y_{it} = 0 \). For a given \( l_i \), we have:

\[
P(y_{it}/l_i) = \Phi\left[\frac{-X_{it}'\eta - l_i}{\sigma}\right]^{d_{it}} \times \phi\left[\frac{y_{it} - X_{it}'\eta - l_i}{\sigma}\right] \times \frac{1}{\sigma}^{d_{it}}
\]

\[
P(y_i/l_i) = \prod_{t=1}^{T} \left[\Phi\left[\frac{-X_{it}'\eta - l_i}{\sigma}\right]^{d_{it}} \times \phi\left[\frac{y_{it} - X_{it}'\eta - l_i}{\sigma}\right] \times \frac{1}{\sigma}^{d_{it}}\right] . \text{ Using Bayes theorem, we can write:}
\]

\[
P(y_i) = \int_{-\infty}^{\infty} \prod_{t=1}^{T} \left[\Phi\left[\frac{-X_{it}'\eta - l_i}{\sigma}\right]^{d_{it}} \times \phi\left[\frac{y_{it} - X_{it}'\eta - l_i}{\sigma}\right] \times \frac{1}{\sigma}^{d_{it}}\right] \frac{1}{\theta} \times \phi\left[\frac{l_i}{\theta}\right] dl_i ,
\]

\[
P(y) = \prod_{i=1}^{N} \int_{-\infty}^{\infty} \prod_{t=1}^{T} \left[\Phi\left[\frac{-X_{it}'\eta - l_i}{\sigma}\right]^{d_{it}} \times \phi\left[\frac{y_{it} - X_{it}'\eta - l_i}{\sigma}\right] \times \frac{1}{\sigma}^{d_{it}}\right] \frac{1}{\theta} \times \phi\left[\frac{l_i}{\theta}\right] dl_i .
\]

\[
\text{Log-L} = \sum_{i=1}^{N} \log \left\{ \prod_{t=1}^{T} \left[\Phi\left[\frac{-X_{it}'\eta - l_i}{\sigma}\right]^{d_{it}} \times \phi\left[\frac{y_{it} - X_{it}'\eta - l_i}{\sigma}\right] \times \frac{1}{\sigma}^{d_{it}}\right] \frac{1}{\theta} \times \phi\left[\frac{l_i}{\theta}\right] \right\} .
\]
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