

The governance of risk management: The importance of directors' independence and financial knowledge

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Abstract

We test the effects of the independence and financial knowledge of directors on risk management and firm value in the gold mining industry. Our original hand-collected database on directors' financial education, accounting background, and financial experience allows us to measure the effect of financial knowledge on risk management activities. We show that directors' financial knowledge increases firm value through the risk management channel. This effect is strengthened by the independence of the directors on the board and on the audit committee. Extending the dimension of education, we show that, following unexpected shocks to gold prices, firms with financially educated directors are more effective in hedging than average firms in the industry. Firms that hedge more also attract highly educated directors on their board and audit committee. As a policy implication, our results suggest adding the experience and education dimensions to the 2002 Sarbanes–Oxley Act and New York Stock Exchange requirements for better governance.

Keywords: Risk management governance, financial knowledge, financial and accounting education of director, financial experience of director, independence of director, policy implications.

JEL Classification: D83, G18, G30, G32, G34, G38.

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Introduction

In this article, we explore different dimensions of directors' financial knowledge and test whether they add value to the firm through the channel of risk management activities. Given the importance regulators have provided to directors' independence, we also address the benefit of independent directors on the board or the audit committee and whether this requirement adds to firm value.

The board of directors' main role is to represent shareholders' interests. The board thus aims to maximize the firm's value. The board oversees the recruitment, compensation and activities of senior managers. Consequently, the roles of compensation and audit committees have received particular scrutiny since the Enron case. The makeup of the Board and its committees has also been discussed extensively because the prominence of non-independent members on a board or its committees may affect the way the board functions.

According to several observers (e.g. Healy and Palepu, 2003), Enron's Board of Directors failed in its role of protecting shareholders and contributed to the firm's bankruptcy. Several board members held information on Enron's management practices such as very high compensation of senior managers and of some board members, and disclosure of false statistics on the company's growth potential to increase the value of stock and options. These board members chose to ignore them or did not disclose them to shareholders.

Researchers recently showed, using data from 31 countries, that managers' manipulation of earnings is positively correlated with the benefits they derive from this practice (on manipulation of earnings by firms see Lev (2003) and the references in the article). The authors were surprised to note the extent that Enron's executive compensation committees kept silent about data manipulation by senior managers. Were these directors really incompetent? Were they in a conflict of interest because they were paid themselves by stock options? Did they have holdings in other companies that were doing business with Enron?

Despite the regulatory attention given to corporate governance through the rules set by the Sarbanes-Oxley Act (SOX) and the New York Stock Exchange (NYSE) in 2002, a report of the Organisation for Economic Co-operation and Development (OECD) attributes the 2007 financial crisis to the failure of the boards in overseeing risk management systems. The OECD report (Kirkpatrick, 2009) mentioned that one of the causes of this crisis was linked to limited knowledge of risk management and a poor understanding of various risks to which the financial institutions' boards of directors were exposed. Several of these firms used very complex structured financial products like commercial paper (ABCP), CDOs (Collateral Debt Obligation) and CDSs (Credit Default Swap). Often, board members were unaware that the company was using these products, or that they were responsible for defining the risk appetite of the enterprise. This diagnosis

emphasizes that board members from firms exposed to major risks need sufficient financial knowledge to oversee risk management effectively. Therefore, even if several board members are independent, they may not have adequate expertise to monitor firm risk management effectively.

The OECD report does not limit the importance of qualified board oversight or the need for robust risk management to financial institutions. Drawing lessons from the 2007 crisis, the report emphasizes the necessity of certifying a minimum level of financial knowledge for the directors on boards and those composing the audit committees of all exposed firms to ensure that they understand issues related to risk exposure and risk management.

We analyse the governance of risk management within North American gold mining companies. We examine how board and audit committee members' independence and financial knowledge could affect firm value via the risk management policy. We analyze very detailed data on financial knowledge of audit committee members and board members for each firm, measured by three components: financial training, financial experience and accounting education. Financial education is defined as holding a university degree in finance (BBA, MBA or M.Sc., PhD, etc.); financial experience is determined by whether a director is active in a financial environment, such as a manager of an insurance company or bank, or a financial analyst. Directors are considered to have an accounting education if they hold a university degree in accounting. We also obtained information on the university degrees held by each board member.

Exploring the link between risk management behavior and directors' financial sophistication has important policy implications. Specifically, we construct a compliance index that accounts for each of the 2002 SOX and NYSE requirements mainly based on director independence. We then test whether the value of firms compliant with these rules increases through better risk management. Our results suggest that compliance with SOX affects risk management activity but, generally, compliance with NYSE regulation does not significantly affect risk management. This suggests that having independent members and at least one educated member on the audit committee is beneficial to risk management policy. However, these results are not fully satisfactory in the sense that compliance with the two regulations does not affect very significantly firm value through the risk management channel.

We also demonstrate that the variables of director independence and financial knowledge can influence risk management policy and that their effects on firm value are highly interrelated. We construct governance indices for the board and the audit committee, made up of different variables including financial knowledge, independence, master and PhD degrees in finance, and separation of the roles of CEO and chairman of the firm's board. We show that these indices have a significant effect on firms' risk management policy and firm value.

Our empirical evidence also highlights the importance of directors' university education and suggests that financially qualified members of the board encourage hedging activities. Moreover, firms with high hedge ratios attract highly educated directors on the board and the audit committee. Most interestingly, we find that firms with financially educated directors are more prompt in

adjusting firms' hedge ratios following shocks in gold prices than the average firms in the industry are. Finally, we analyze how option hedging by officers affect their risk management behavior.

The remainder of the paper is organized as follows. Section 1 presents the regulatory background from Enron bankruptcy in 2001 to the recent financial crisis. Section 2 documents the related literature and sketches the testable hypothesis. Section 3 describes our sample construction and variable definitions and Section 4 presents the summary statistics of our sample. Section 5 motivates our empirical approach and presents our main empirical results. Section 6 discusses the policy implications of our contribution and Section 7 discusses our results on option holdings and risk management. We then conclude the paper by discussing more recent regulations of financial institutions.

1. Regulatory background

Since Enron declared bankruptcy in December 2001, several governance rules have been discussed and applied in the world.

The Sarbanes-Oxley (SOX) Act, signed on July 30, 2002, by the US president, amends the Securities and Exchange Act of 1934 and urges the Securities and Exchange Commission (SEC) to enforce compliance with the amendments, enact regulations and apply controls to protect the public and investors when the legislation is applied. This law also created the Public Company Accounting Oversight Board (PCAOB), which reports on public firms audit to the SEC. The PCAOB studies various recommendations submitted by the public, along with several organizations and associations, including the NYSE and NASDAQ, in order to draft new regulations. Accordingly, the SEC has set forth minimal requirements concerning the audit committee which must be made up of independent board members exclusively. As required by the SOX, the SEC and the Comptroller General of the United States pursued studies to clarify and modify the standards for listing on an exchange (Blanchard and Dionne, 2004).

On February 13, 2002, the SEC asked the New York Stock Exchange (NYSE) to revise its policy concerning the governance standards and requirements for firms listed on that exchange. On August 1, 2002, the NYSE board approved the following measures:

1. The composition of boards of directors must consist of a majority of independent directors;
2. The nominating/corporate governance committee and the compensation committee must be composed entirely of independent directors;
3. Each listed company must include a minimum of three people on its audit committee, composed exclusively of independent directors;
4. Each listed company must have an internal audit function;
5. Listed companies must adopt minimum standard rules and disclose their guidelines concerning corporate governance.

The notion of independence is technical, and its definition is lengthy. There is insufficient space to present it here. Interested readers should consult Jenner and Block (2003). However, this contribution does not specify anything about the risk committee, although it mentions that, according to the new 2002 regulation, the audit committee must discuss risk management assessment and policies. According to this interpretation, company management is responsible for risk management. It must evaluate and manage the firm's exposure to different risks. In absence of a risk committee, the audit committee must discuss policies and guidelines governing the process for assessing the main risks that the company faces, as well as the risk management measures applied.

2. Literature review and main hypotheses

The main hypothesis to be tested is that corporate governance indexes for the board and the audit committee constructed using information regarding independence and financial knowledge of the directors should improve firm value through the risk management channel.

- The board as a corporate governance mechanism

The board of directors plays a central role in any corporate governance system and is viewed as a primary means for shareholders to exercise control over higher management (Tirole, 2006). Specifically, board composition, independence and engagement are key features in enhancing a firm's corporate governance system and achieving its performance goals. For instance, Armstrong, Core and Guay (2014) show how the structure of a board dominated by related directors increases both the level of information asymmetry between shareholders and higher management and uncertainty about firm value. A board structure dominated by independent directors has the opposite effect and leads to an increase in firm transparency and an increase in firm value.

A tremendous amount of the literature focuses on board structure, specifically member independence but with little emphasis on the value of the board's financial knowledge. Moreover, the 2002 regulations provided by SOX and the NYSE do not explicitly require financial knowledge for the board members; it is only explicitly required for accounting knowledge in audit committee. The following analyses focuses on the importance of the financial knowledge dimension in board structure. Specifically, it examines the effect of having directors on the board and audit committee with relevant experience and/or education in finance on the firm's risk management activity and its performance on firm value.

- Benefit of financial knowledge for the board

The few papers that investigate the financial knowledge argument for board members support the idea that the financial knowledge of directors adds value to the firm. Indeed, Guner, Malmendier and Tate (2005) show that boards composed of members with relevant and related financial and accounting knowledge obtain credible and high-quality financial statement evaluations. Agrawal and Chadha (2005) support the benefit of having independent board directors who have financial knowledge. They found that the probability of earnings restatements is lower in firms whose boards

have an independent director with a background in accounting or finance. Interestingly, the independence argument taken alone seems to have no explanatory power in their model, which suggests that directors' independence becomes more effective when they also have financial knowledge.

To the extent that financially knowledgeable directors have a better understanding of the sophisticated financial tools involved in risk management activities, we may expect firms whose boards are composed of financially knowledgeable directors to engage more actively in hedging the firm's exposure to risk and enhance its effect on firm value.

Different arguments support the prediction that financial knowledge should benefit the firm and its shareholders, particularly in the mining industry. First, derivatives are sophisticated instruments and directors need a minimum level of financial knowledge to understand them and adequately monitor their management. That is, fixing the optimal level of risk management and choosing appropriately between options or futures instruments in different risky environments. In addition, directors overseeing risk management need to understand that derivatives can affect officers' incentives (CFO and CEO) to act in line with shareholder welfare.

Second, financial knowledge is often measured by directors' experience in finance and their background in accounting. There is no explicit consideration of the financial education dimension, which may be relevant to the usage of hedging instruments and the understanding of other issues relating risk management and firm value. For instance, some directors have knowledge related to their business activities (engineers, communication specialists, lawyers, etc.) but not to finance. These directors may not be aware of all the available instruments to hedge a firm's exposure to risk and may not even fully understand the costs and benefits of the effective usage of sophisticated financial instruments and their control. Thus we propose the following hypothesis.

H1: The financial knowledge of directors sitting on the board should have a significant effect on firm value through the optimal risk management activities channel.

- Benefit of financial knowledge for the audit committee

The audit committee's primary task is to oversee the firm's corporate reporting and ensure the reliability of its financial reporting. Periodic review of the firm's risk assessment system and the managerial actions used to manage its risks is a critical step toward fulfilling this task. We would expect audit committees satisfying the SOX and/or NYSE rules to provide effective monitoring. Moreover, the NYSE's rules require the audit committee to discuss the guidelines and policies for risk assessment and risk management.

No previous study establishes a relation between the composition of the audit committee, the background of its members and corporate hedging. We propose the first contribution to establish such a link. Because audit committee members with financial backgrounds have the experience and training to understand risk management operations, we expect firms with financially knowledgeable directors to engage more actively in risk management to increase firm value. The

audit committee, through its monitoring role, should be qualified to deal with the financial environment, especially in critical financial episodes. We then propose the following hypothesis.

H2: The financial knowledge of directors sitting on the audit committee should have a significant effect on firm value through the risk management activities channel.

- Independence argument

In corporate finance, the standard approach is to view the board's independence as being closely related to its efficiency. Following the same reasoning, Section 303A.01 of the NYSE's listed companies manual requires a majority of independent directors on the board. Indeed, outside directors are viewed as superior monitors because their careers are not tied to the firm's CEO. Consequently, they are free to take decisions that may go against the CEO without being afraid for their positions or future compensation. This view is often referred to as the monitoring effect theory.

Outside directors also have incentives to build their reputation as expert monitors to obtain additional director appointments. Thus, they are more likely to maintain proper control over the firm's higher management. However, they are faced with the challenge of understanding the firm's operations, which puts their reputation in play in case of failure. Armstrong, Core and Guay (2014) show that firms with more independent directors sitting on the board are more transparent. This has the effect of reducing the uncertainty about the firm's cash flows and thus increasing its value.

The independence argument is also a concern for members of the audit committee. A large body of academic literature has investigated the extent to which the independence and financial literacy/expertise of the audit committee members are beneficial to shareholders, specifically members with an accounting background. However, another stand in the literature questions the benefits of having independent directors on the audit committee. There is no consensus that the presence of outside auditors provides additional benefits to the firm. For instance, Agrawal and Chadha (2005) provide arguments against the benefits of having independent members, while Carcello and Neal (2000) show that the presence of independent members is beneficial to the firm.

Few papers link board composition to firm risk management activity. Again, the literature does not arrive a clear consensus on the effect of outside directors on a firm's risk management policy. For instance, Mardsen and Prevost (2005) report no effect of having outside directors on risk management activities. However, Fields and Keys (2003) claim overwhelming support for outside directors providing superior monitoring and advisory functions to the firm. Dionne and Triki (2013) find that hedging increases with outside directors on the board because they can better monitor the personal goals of officers with respect to hedging.

Since risk management is a complex activity, we argue that the requirement of director independence is beneficiary but not enough. Independent members of the board and the audit committee also need a minimum level of financial knowledge (education, experience and accounting) to monitor risk management activities. Many analysts of the 2007 financial crisis have

mentioned that existing regulations are more focused on independence and accounting education than on financial knowledge. We then propose this third hypothesis.

H3: The independence of directors should have a significant effect on risk management activities and firm value through its interaction with financial knowledge.

We analyze the endogeneity issue related to the presence of qualified directors on the board and the audit committee (Wintoki et al, 2012). As a referee pointed out, firms that want to hedge effectively should hire directors with financial background.

H4: Firm that hedge more should attract more qualified directors with financial background.

Finally, we argue that the dynamic management of derivative instruments requires a minimum level of financial sophistication and expertise. Extending the above argument, we propose that firms with directors with higher financial education are more willing to react to unanticipated changes in gold prices by making proper adjustments to risk management policy to limit the firm's exposure to risk. Thus, we propose the following testable hypothesis.

H5: Firms with more financially educated directors should be more effective than the average industry in adjusting their hedging behavior following unexpected shocks to gold prices.

3. Data and variables

Based on the observed hedging activities, we construct quarterly hedge ratios for each company during the 1992-1999 period. An important feature of our data is the fact that our sample covers the period preceding major corporate governance problems (e.g., Enron, WorldCom) and the preparatory work that led to the 2002 enforcement of the changes in corporate governance regulation. Therefore, the observed structures of the boards and audit committees in our sample of firms do not reflect changes made to comply with these regulations. They were freely determined by the firms.

Our data provide an independent yet unique assessment of the benefits of different private governance rules on risk management activities in addition to those observed in the 2002 regulations. Gold mining firms share a common exposure to the risk of changes in the gold price. Adam and Fernando (2006) show that most gold mining firms use options to hedge gold prices during our period of analysis. Given the multiplicity of hedging instruments available as well as this commodity's high level of liquidity, the risk of fluctuation of the gold price must be adequately managed. Thus, what should make the difference between different hedging positions in this particular industry likely reflects differences in firm characteristics, including the level of directors' financial knowledge and independence. By addressing the effect of directors' financial knowledge on hedging, we also verify the effectiveness of this requirement for hedging activities in this sector. Another important feature of our data lies in the benefits of having detailed information about the financial university education and financial experience of directors carefully hand-collected from various sources listed in Appendix A. Our data allow us to explore the diversity of directors'

backgrounds in the financial sector and test the distinct effects of financial education and experience on firm hedging behavior.

- Sample construction (1992-1999)

Observations on the composition of the board and the audit committee are published only on an annual basis in the firm proxy statement. We assume that the characteristics of corporate governance for the firm remain constant between two consecutive general annual meetings. We argue that this assumption is reasonable since directors are usually elected for terms of at least one year. Moreover, the main issues of corporate governance (risk appetite, risk management policy, risk management strategy, control process) are usually discussed once a year with the board.

Compustat Quarterly is used to collect firm-specific data such as the market and book values of assets, the total value of debt, the value of sales, operating income, acquisition expenses, selling and general expenses, depreciation and amortization and other data needed to compute variables describing firms' general characteristics. Firms' proxy statements and annual reports provide hand-collected information about the size and composition of the board and the audit committee, the name of each director sitting on the board and on the audit committee, the education level of each director, the current and former functions of each director, the age of the CEO and the CEO's portfolio holding of common shares and exercisable options.

Data relative to firms' operating cash costs and exploration expenditures were obtained from quarterly reports. They proxy taxable income by taxable accounting earnings before extraordinary items and discounted operations. This information is needed to construct the Tax_save variable (Dionne and Triki, 2013). Data about institutional shareholding are from the 13-F and 13-G forms available on the U.S. Securities and Exchange Commission website and from proxy statements.

We first break down the definition of the financial literacy of directors into three categories. A director has a financial knowledge if he or she is i) financially active or has financial experience, ii) is financially educated, or iii) possesses an accounting background. Directors are independent if they are not related to the management of the firm and are free from any interest or relationship that could conceivably affect their ability to act in the firm's best interest, other than interest arising from shareholdings. Directors are financially active or have experience if they presently or formerly occupied a position as chief financial officer, treasurer, officer of an insurance or investment company or a mutual fund, financial analyst, financial consultant, banker, or any other position related to finance. Directors are financially educated if they hold a finance degree or were enrolled in a program offering finance courses (BBA, MBA, CA, BCom, etc.). Several directors in the sample had been enrolled in qualified professional programs. Finally, directors are accountants if they have an accounting background or are Chartered Accountants (CA, CPA) or have an education or activities related to accounting.

The final sample consists of 325 observations with complete information about the educational background of the directors and 343 observations with complete information about all

the other variables used in the analysis. The sample contains 36 North American gold mining companies composed of 20 Canadian firms and 16 U.S. firms.

- Variable definitions

Dependent variable

Following Tufano (1996), a firm's risk management activity is measured by the delta percentage. Firm value variables are discussed below.

Governance variables

The main research question aims to evaluate the impact of directors' independence and financial knowledge when sitting on the board and/or the audit committee on firm value through corporate hedging behavior. Therefore, the choice of key independent variables is dictated by the two sets of governance.

Two governance indexes are then constructed to account for all of these governance features and test the effect of governance on the firm's risk management behavior. Specifically, we use a scoring system to assess the quality of the audit committee and the board. The score is built such that it increases with each dimension of financial knowledge. It also increases with compliance with the SOX and NYSE requirements of independence and their definition of financial knowledge. However, the score decreases with the CEO level of entrenchment and with directors' tenure. Tenured directors who served the same company for at least 10 years should have acquired relevant experience and learned from the different challenges across various economic regimes. Derivative instruments were relatively new during the sample period and we are thus inclined to discount the high numbers of tenured directors simply because they may not have developed enough knowledge and experience with these new instruments. We document the construction of both indexes—one for the audit committee and one for the board (*Gov_index_aud* and *Gov_index_bor*, respectively)—in Appendix B. As robustness of our research, we reconstruct the two governance indexes using Principal Component Analysis (PCA).

Control variables

We use different determinants of risk management that are well documented in the literature (e.g. Tufano, 1996; Dionne and Garand, 2003; Adams and Fernando, 2006; Dionne and Triki, 2013). Specifically, firm size ($\ln(\text{size})$), the market-to-book ratio of assets (market-to-book), the dividend policy (dividend policy) and the existence of financial liquidity (quick ratio) are used. The firm's expected financial distress costs using leverage (leverage) and the firm's operating cash costs (cash cost) are also included. Financial distress costs should increase firm incentives to hedge (Tufano, 1996). Similarly, we control for the firm's investment opportunities using its exploration expenditures (exploration). Firms with attractive investment opportunities should hedge more extensively to ensure the availability of internal funding necessary to undertake these investments (Froot, Scharfstein and Stein, 1993). Finally, the firm's home country is considered by including a variable (dummy U.S.) that equals to one if the firm's origin country is the United States.

As Graham and Rogers (2002), the percentage of shares held by institutions (*%inst*) is used as a proxy for information asymmetry between the CEO and shareholders. This variable can also indicate that these shareholders are more diversified. Risk management activities should decrease with the importance of the firm's institutional holdings as they are willing to take more risk than other stakeholders do.

A firm with a convex tax function should have more incentives to hedge (Smith and Stulz, 1985; Graham and Rogers, 2002; Dionne and Triki, 2013). Hedging allows the firm to lock the level of taxable income, thus reducing the variability of the pre-tax assets value and tax liability and increasing the after-tax value of assets. To capture the benefits of a convex tax function on hedging, the tax save variable (*Tax_save*) proposed by Graham and Smith (1999) is constructed. The definition is extended to include the country of origin's legislation and tax code.

Managerial risk aversion is another important determinant of risk management policy in the gold mining industry (Tufano, 1996). Two proxies for managerial risk aversion are used: The number of the firm's common shares held by the CEO (*CEO_CS*), and the value of options held by the CEO (*ValCEO_Op*). The two variables capture Smith and Stulz's (1985) argument that compensation packages leading to a concave (convex) function between the managers' utility function and the firm's value encourage managers to hedge more (less).

The variable CEO age potentially captures the interplay between experience and education. The literature argues in favor of both positive and negative relations between director age and hedging activity. Younger directors may be more inclined to hedge, and older directors facing imminent retirement might prefer to reduce fluctuations in a firm's value and hence hedge more extensively. But some may find derivatives dangerous. The variables definitions are presented in Appendix C.

4. Summary statistics

Table 1 reports the descriptive statistics for our test and control variables. The hedge ratio indicates that firms in our sample hedge about 25% of their production of gold (as indicated by the mean of the hedge ratio). The hedge ratio also takes on values greater than one. The maximum of the hedge ratio equals 1.26. We verify that in 17 quarterly observations, the hedge ratio is equal to or higher than one. Therefore, some gold mining firms are likely to hedge for speculation reasons, consistent with the results of Adam and Fernando (2006), who find evidence of speculation (or selective hedging) in the industry of gold mining. Moreover, their results suggest that these firms realize marginal gains from selective hedging.

Panel B of Table 1 provides summary statistics of the general characteristics of the firms. Noticeably, our sample contains mostly Canadian firms. Institutions hold, on average, 8% of the shares of the firms, while blockholders hold, on average, 18% of the shares.

Panel C of Table 1 provides summary statistics for the general characteristics of the CEO. The median director CEO is 54 years old. The average tenure is about six years for the CEOs,

which means that they acquired experience with the company. We also note that 68% of the CEOs in our sample are also the chair of the Board at the same time.

Panels D and E of Table 1 provide descriptive statistics of the financial backgrounds of directors sitting on the audit committee and the board, respectively. The audit committee is mostly composed of at least three members (Min_size). In 53% (61%) of cases, the members of the audit committee (board) are independent. The audit committee is composed of at least one financially educated member in 89% of cases. Few firms (29%) have an audit committee entirely composed of financially active or financially educated members. In about 60% of the firms, directors sitting on the board or the audit committee have a bachelor's degree and, in about 15% of cases, they have a master's or PhD degree in finance. In 42% (71%) of cases, the audit committee (board) comprises at least one accountant.

TABLE 1 – Descriptive statistics

This table reports summary statistics (number of observations, mean, median, standard deviation, minimum, and maximum) of all the variables in our analysis. The variable definitions are reported in Appendix C. For the hedge ratio, we report i) the continuous hedge ratio variable for all firms, ii) a positive hedge ratio variable for firms that hedge.

Variables	N	Mean	Median	Std Dev.	Min	Max
Panel A: Dependent variables						
<i>Hedge_Ratio (all firms)</i>	348	0.25	0.14	0.30	0.00	1.26
<i>Hedge_Ratio (firms that hedge)</i>	294	0.30	0.17	0.30	0.00	1.26
Panel B: General characteristics of the firms						
<i>Ln(size)</i>	344	6.50	6.43	1.49	3.00	9.37
<i>Market_to_Book</i>	344	1.76	1.64	0.92	0.42	6.00
<i>Leverage</i>	343	0.49	0.30	0.57	0.00	3.64
<i>Quick_Ratio</i>	348	3.03	2.08	2.63	0.01	13.50
<i>Dividend_Policy</i>	348	0.76	1.00	0.43	0.00	1.00
<i>Tax_Save</i>	348	0.14	0.05	0.26	0.00	2.18
<i>%_Inst</i>	348	0.08	0.06	0.09	0.00	0.40
<i>%_Blockholders</i>	348	0.18	0.11	0.26	0.00	0.91
<i>Exploration (×10²)</i>	348	0.36	0.24	0.99	0.00	17.39
<i>Cash_Cost</i>	348	246.07	234.00	64.70	116.00	491.00
<i>Gold_Price</i>	348	335.75	333.65	42.25	280.45	394.00
<i>US_dummy</i>	348	0.45	0.00	0.49	0.00	1.00
Panel C: Characteristics of directors and CEOs						
<i>CEO_Age</i>	348	53.95	54.00	7.54	40.00	75.00
<i>CEO_Tenure</i>	348	6.31	5.00	4.78	0.00	17.00
<i>CEO_COB</i>	348	0.68	1.00	0.47	0.00	1.00
<i>CEO_Change</i>	348	1.11	0.00	0.32	0.00	1.00
<i>CEO_CS</i>	348	1.18	0.06	3.18	0.00	18.01

Variables	N	Mean	Median	Std Dev.	Min	Max
<i>ValCEO_Op</i>	348	1.70	0.00	6.72	0.00	43.81
<i>ValAll_Op</i>	344	1.38	0.58	2.17	0.00	9.26
<i>Cash_Fee_Outsiders</i>	348	0.63	0.72	0.36	0.00	1.10
<i>Annual_Fixed_Fee</i>	348	11.69	8.00	11.45	0.00	50.00
<i>CEO_Bachelor</i>	348	0.15	0.00	0.35	0.00	1.00
<i>CEO_High_Edu</i>	348	0.07	0.00	0.25	0.00	1.00
Panel D: Characteristics and financial background of directors on the audit committee						
<i>Min_size</i>	348	0.91	1.00	0.29	0.00	1.00
<i>Tot_indep</i>	348	0.53	1.00	0.50	0.00	1.00
<i>One_Acc</i>	345	0.42	0.00	0.49	0.00	1.00
<i>One_Fin_know</i>	348	0.89	1.00	0.30	0.00	1.00
<i>One_Act_Edu_Acc</i>	348	0.32	0.00	0.47	0.00	1.00
<i>One_Act_Edu_NotAcc</i>	348	0.24	0.00	0.43	0.00	1.00
<i>One_Act_NotEdu_NotAcc</i>	348	0.42	0.00	0.49	0.00	1.00
<i>One_NotAct_Edu_Acc</i>	348	0.22	0.00	0.41	0.00	1.00
<i>One_NotAct_Edu_NotAcc</i>	348	0.39	0.00	0.49	0.00	1.00
<i>%_Act_Edu_Acc</i>	345	0.12	0.00	0.19	0.00	0.67
<i>%_Act_Edu_NotAcc</i>	345	0.11	0.00	0.23	0.00	1.00
<i>%_Act_NotEdu_NotAcc</i>	345	0.14	0.00	0.18	0.00	0.50
<i>%_NotAct_Edu_Acc</i>	345	0.07	0.00	0.14	0.00	0.50
<i>%_NotAct_Edu_NotAcc</i>	345	0.14	0.00	0.21	0.00	1.00
<i>%_Bachelor</i>	325	0.62	0.67	0.28	0.00	1.00
<i>%_High_Edu</i>	345	0.16	0.00	0.24	0.00	1.00
<i>%_Acc</i>	348	0.19	0.00	0.25	0.00	1.00
<i>All_Fin_know</i>	348	0.29	0.00	0.45	0.00	1.00
<i>Num_High_Edu</i>	348	0.50	0.00	0.73	0.00	3.00

Variables	N	Mean	Median	Std Dev.	Min	Max
Panel E: Characteristics and financial background of Directors on the board						
<i>Maj_Indep_Bor</i>	348	0.75	1.00	0.44	0.00	1.00
<i>%_Indep</i>	348	0.61	0.60	0.19	0.14	1.00
<i>%_Act</i>	348	0.26	0.24	0.15	0.00	0.71
<i>%_Act_Edu_Acc</i>	345	0.12	0.00	0.19	0.00	0.567
<i>%_Act_Edu_NotAcc</i>	345	0.11	0.00	0.23	0.00	1.00
<i>%_Act_NotEdu_NotAcc</i>	345	0.07	0.00	0.14	0.00	0.50
<i>%_NotAct_Edu_Acc</i>	345	0.14	0.00	0.21	0.00	1.00
<i>%_NotAct_Edu_NotAcc</i>	348	0.11	0.09	0.12	0.00	0.44
<i>%_Bachelor</i>	325	0.61	0.60	0.17	0.29	1.00
<i>%_High_Edu</i>	348	0.13	0.08	0.16	0.00	0.71
<i>One_Acc</i>	348	0.71	1.00	0.45	0.00	1.00
<i>%_Acc</i>	348	0.13	0.13	0.11	0.00	0.43
<i>Num_High_Edu</i>	348	1.19	1.00	1.39	0.00	6.00

5. Model and empirical results

5.1 Model

The dependent variable, the hedge ratio, has nonnegative values. In about 16% of the observations in the sample, the hedge ratio is equal to zero. An observed hedge ratio of zero may reflect managements' decision to not hedge. Therefore, the Heckman (1979) two-stage model could be best suited to represent the data. However, the results in Dionne et al (2018) show that using two-stage estimation does not affect the results, indicating that the data does not seem to suffer from selection bias, so we limit the discussion to standard one-stage estimation for the hedging equation.

When estimating the effect of hedging on firm value, we are faced with an endogeneity problem. Adams et al (2010) document this issue and report a lack of sufficient instrumental analyses in the corporate governance literature. Many results must be interpreted as the joint selection of governance policy and the policy's effect on firm performance. For example, a firm's hedging activity can be correlated with the unobservable characteristics of the firm, in which case the ordinary least square estimates of the parameters in the firm value equation could be biased. We address this endogeneity issue using a suitable instrument for the hedging equation. As Campello et al (2011) and Dionne and Triki (2013), we use the government rules on corporate taxes that capture tax convexity. This measure will then serve as an instrument in the hedging equation and it is measured as the variation in expected tax savings from an exogenous 5% reduction in the volatility of taxable income (Graham and Smith, 1999). The key argument is that tax convexity provides incentives to increase hedging, but there is no reason to expect it to directly affect the value of the firm; it is more the level of tax that affects firm value not the convexity of the tax function. Under this premise, tax convexity should be an adequate instrument for hedging.

Since we use panel data, we compute robust standard errors in single equation estimations (https://www.stata.com/manuals13/xtvce_options.pdf). In simultaneous equations, matters are less simple because available formula do not exist to compute unbiased standard errors. So we apply the bootstrap procedure to obtain a bootstrap distribution of the sampling data and use the bootstrap distribution to estimate the standard errors corrected for within-firm clustering (<https://www.stata.com/manuals13/rbootstrap.pdf>).

5.2 Empirical results

- Control variables

Throughout all regressions of the paper, we include many control variables widely used in the literature to explain risk management (e.g., Tufano, 1996; Graham and Rogers, 2002; Dionne and Garand, 2003; Adam and Fernando, 2006; Campello et al, 2011). Many of them are statistically significant, with the predicted sign (see Table 3, Panel A, for example). Specifically, the leverage has a positive and significant sign, suggesting that highly leveraged firms hedge more to reduce

their expected default costs (Stulz, 1996). The tax advantage measured by the convexity of the tax function also has a positive and significant sign, as predicted (see also Campello et al, 2011; Dionne and Triki, 2013). Firms hedge ex ante to reduce their expected tax payments. The percentage of institutional holdings (%_inst) reduces the propensity of hedging. Intuitively, these large institutions are well diversified and less prone to hedge. Institutional holdings can also reduce the information asymmetry between the CEO and shareholders. Finally, we also find that CEO shareholdings (CEO_CS) increase the firm's hedging activity, whereas CEO option holdings (ValCEO_Op) decrease it. The argument is that risk-averse CEOs with higher shareholdings tend to protect their personal capital by hedging more. Those with high option holdings will tend to hedge less to increase the value of their options (Stulz, 1996; Tufano, 1996) particularly when options are out-of-the-money. However, the second argument may not support the dynamic behavior of risk-averse investors with options in-the-money as shown by Carpenter (2000). We address this argument in the last section of the paper.

We also find that size, gold price, quick ratio, and market-to-book are not always significant while dividend policy and CEO age are not significant.

- Importance of financial knowledge

Dionne et al (2018) start their analysis with a test on the effect of the financial knowledge of members of the audit committee and the board using their broad definition of financial knowledge (i.e., experience combined with education in finance and accounting). The sample is about 89% comprised of audit committees with at least one member with financial knowledge (who may also be educated and an accountant) and 53% comprised of committees that are totally independent. We also observe that 61% of the board members are independent and have a Bachelor degree.

Their results show that the independence, financial knowledge, and academic background of members of the audit committee and the board affect the firm's hedging behavior. The members of the board are directly responsible for the firm's risk management strategy, whereas the audit committee members monitor and control board decisions that can affect hedging decisions. The results suggest that independence is very important for the audit committee and less important for members of the board. However, independence plays a key role in defining the sign of the effect of financial knowledge dimensions on the firm's hedging behavior for both the audit committee and the board. Thus, the three dimensions of financial knowledge should affect corporate governance, along with independence.

- Results with governance indexes

In Table 2, the effect of the governance indexes on the firm's risk management behavior is tested using multivariate regressions. Equations (1) to (3) refers to the effects of adding the governance index defined in Appendix B for the audit, the board, or both, respectively. The three regressions contain the same control variables as in Panel A of Table 3. In all cases, we observe that the quality of the audit committee and board significantly affects the observed hedging

behavior for the firms in the sample. The higher the governance index, the higher the firm's hedging activity. The control variables remain stable between the different equations.

Thus, consistent with our predictions, a firm with sound corporate governance is actively hedging its gold position using the derivatives market. Consequently, financial knowledge and independence are important indicators of corporate governance in building indexes. We now have to verify whether sound corporate governance based on the financial knowledge dimensions also increases shareholder value through the risk management channel.

TABLE 2 – Effect of governance indexes on hedging activities

	(1)	(2)	(3)
<i>Gov_index_audit</i>	0.043*** (0.02)		0.042*** (0.02)
<i>Gov_index_board</i>		0.026*** (0.01)	0.024** (0.01)
<i>Controls & Intercept</i>	Yes	Yes	Yes
<i>R-Squared</i>	0.22	0.21	0.23
<i>F-Value (p-value)</i>	5.78 (0.00)	5.40 (0.00)	5.70 (0.00)
<i>Observations</i>	342	342	342

Notes: The effect of governance quality on firm hedging behavior is reported. Governance quality is measured by two indexes: *Gov_index_board* (for the board) and *Gov_index_audit* (for the audit committee). The construction of both indexes is detailed in Appendix B. The dependent variable is the delta percentage of the firm. The table reports the partial results of the multivariate regressions. All the regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. Robust standard errors are in parentheses. The superscripts *** and ** denote significance at the 1% and 5% levels, respectively.

- Hedging behavior and firm performance

Several studies address the questions of whether hedging (Adam and Fernando, 2006; Dionne and Mnasri, 2018) and enterprise risk management (ERM) (Hoyt and Liebenberg, 2011) increase the shareholder value. In line with the literature, we may question whether the governance indexes accounting for the quality of directors in terms of financial expertise and independence increase firm value through the risk management channel. Table 3 reports the results of simultaneous estimation. Three measures of firm performance are used: two accounting, Return on Equity (ROE), Return on Assets (ROA), and one market the Tobin's q .

There is no evidence of strong feedback effects between observed hedging and firm performance. As shown in Table 3 Panel A, firm performance does not seem to affect hedging

levels with one exception for ROE. Hedging activities in firms with qualified boards and audit committees increase both the firms' accounting and market performance (ROE and Tobin's q , Panel B). This result supports the views suggesting that risk management is beneficial to firms and their shareholders, while risk management is not strongly affected by firm performance.

The measures for governance indexes (Panel A) are always positive and significant, suggesting that the directors' financial expertise affects hedging behavior and leads firms to hedge more. The coefficients are stable between regressions and are similar to those of Table 2. The positive relation between the price of gold and firm performance is intuitive since firms make more profits when the gold market is bullish because they can close up their positions and sell the gold at a higher price in the spot market. The instrument variable (Tax_save) in the hedge equation is positive and significant, suggesting that the model does not seem to suffer from endogeneity issues. Many control variables are significant with appropriate coefficient sign, as in previous literature.

TABLE 3 – Simultaneous hedging and firm performance estimation

	ROE	ROA	Tobin's q
Panel A: The hedge ratio is the dependent variable			
<i>Firm_performance</i>	0.122*** (0.01)	0.143 (0.57)	-0.023 (0.08)
<i>Ln(size)</i>	0.120*** (0.04)	0.122 (0.10)	0.110*** (0.03)
<i>Market-to-book</i>	-0.037*** (0.00)	-0.040 (0.06)	
<i>Leverage</i>	0.098** (0.04)	0.098 (0.10)	0.083*** (0.02)
<i>Quick_ratio</i>	-0.004*** (0.00)	-0.005 (0.01)	-0.005 (0.01)
<i>Dividend-policy</i>	-0.003 (0.02)	-0.003 (0.03)	-0.007 (0.03)
<i>Tax_save</i>	0.180* (0.09)	0.189*** (0.04)	0.175** (0.07)
<i>CEO_CS</i>	0.095*** (0.03)	0.105* (0.06)	0.118*** (0.04)
<i>ValCEO_Op</i>	-0.006*** (0.00)	-0.006*** (0.00)	-0.007** (0.00)
<i>%_inst</i>	-0.572*** (0.12)	-0.606*** (0.15)	-0.596*** (0.07)

	ROE	ROA	Tobin's q
<i>CEO-age</i>	0.001 (0.00)	0.001 (0.00)	0.001*** (0.00)
<i>US_dummy</i>	2.088*** (0.72)	2.282*** (0.75)	-0.303* (0.18)
<i>Gov_index_audit</i>	0.042*** (0.01)	0.044*** (0.01)	0.049*** (0.01)
<i>Gov_index_board</i>	0.021** (0.01)	0.024*** (0.01)	0.022*** (0.00)
<i>Gold_price</i>	-0.001** (0.00)	-0.001 (0.00)	-0.001 (0.00)
<i>Intercept</i>	-2.434** (0.99)	-2.668*** (0.23)	-2.223** (0.60)
<i>Chi-2 (p-value)</i>	1322.2 (0.00)	1322.4 (0.00)	2553.9 (0.00)
<i>Observations</i>	343	343	343

Panel B: The firm value is the dependent variable

<i>Hedge_ratio</i>	0.625*** (0.18)	0.256 (0.19)	0.848*** (0.33)
<i>Ln(size)</i>	-0.083** (0.04)	-0.070 (0.07)	0.370*** (0.01)
<i>Market-to-book</i>	-0.025 (0.04)	0.000 (0.02)	
<i>Leverage</i>	-0.130 (0.12)	-0.094 (0.09)	0.132*** (0.04)
<i>Quick_ratio</i>	-0.008 (0.01)	0.001 (0.00)	-0.006*** (0.00)
<i>Dividend_policy</i>	-0.028* (0.02)	-0.002 (0.02)	0.117*** (0.01)
<i>Exploration</i>	1.401*** (0.09)	-1.606** (0.65)	0.392 (2.22)
<i>Cash_cost</i>	-0.001*** (0.00)	-0.000 (0.00)	-0.002*** (0.00)
<i>%_inst</i>	-0.152 (0.34)	0.121 (0.18)	-1.634 (1.07)
<i>%_blockholders</i>	0.509***	0.127	3.341***

	ROE	ROA	Tobin's q
	(0.12)	(0.11)	(1.20)
<i>Maj_indep_bor</i>	-0.042 (0.03)	0.007 (0.02)	-0.160* (0.09)
<i>CEO_age</i>	-0.007 (0.01)	-0.001 (0.00)	-0.006*** (0.00)
<i>CEO_change</i>	-0.020 (0.02)	0.006 (0.01)	-0.198*** (0.07)
<i>CEO_COB</i>	0.026 (0.04)	0.037 (0.04)	-0.145** (0.06)
<i>CEO_tenure</i>	0.010*** (0.00)	0.001 (0.01)	0.022*** (0.00)
<i>US_dummy</i>	-1.558 (1.17)	0.208* (0.11)	0.185*** (0.00)
<i>Gold_price</i>	0.002** (0.00)	0.000 (0.00)	0.010*** (0.00)
<i>Intercept</i>	1.848 (1.75)	0.258 (1.75)	-3.975*** (0.28)
<i>Chi-2 (p-value)</i>	152.1 (0.00)	123.5 (0.00)	1780.9 (0.00)
Observations	343	343	343

Notes: This table reports the effect of having qualified and independent directors sitting on the board and the audit committee on the hedging behavior and performance of the firm. Panel A reports hedge ratio equation estimates and Panel B reports firm performance equation estimates. Governance quality is measured by two indexes: *Gov_index_board* (for the board) and *Gov_index_audit* (for the audit committee). The construction of both indexes is detailed in Appendix B. Simultaneous estimation of hedging and firm performance is made to account for endogeneity between the two variables. The system is based on Zellner's SURE combined with a two-stage least squares estimation for each equation. The return on equity (ROE) and return on assets (ROA) measure the firm's accounting performance. Tobin's q measures firm market performance. All the regressions have firm effects and include a dummy variable for each quarter to control for seasonal effects in the data. The standard errors in parentheses were obtained from bootstrap analysis. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

5.3 Robustness results from PCA analysis

Governance quality, not observed directly, has a number of aspects that cannot be captured by a single measure. Because direct measures of governance are unavailable, most previous empirical studies use different proxies or create indexes to measure governance quality. In this section, we extend the analysis of Section 5.2 by constructing two alternative governance indexes

by applying principal component analysis (PCA) to our governance variables for the board and the audit committee (variable definitions in Appendix B). Specifically, each governance index represents the principal factor that accounts for most of the variation across the different governance variables. This factor is simply defined as a linear combination of governance variables, where the loadings are determined by the PCA. Since our governance variables are dichotomous (zero/one), our PCA is based on the tetrachoric correlation matrix adapted for such variables (e.g., the SAS package for the principal component procedure).

Tetrachoric correlations assume a latent bivariate normal distribution for each pair of discrete variables. The means and variances of the latent variables are not identified, but their correlations can be estimated (Edwards and Edwards, 1984). One can compute pairwise estimates of the tetrachoric correlations using the maximum likelihood estimator obtained from bivariate probit estimations without explanatory variables. The pairwise correlations matrix can then be used to perform a PCA of the binary variables. Tetrachoric correlations permit an intuitive understanding of the size of correlations and this intuition is based on correlations that range from -1 to +1. Results are reported in Appendix D.

In each case, we retain the first principal component (C1), which explains most (47%) of the total variation for governance variables related to the audit committee and (37%) of the total variation for governance variables related to the board. We use these two components as explanatory variables in the simultaneous system of regressions testing the effect of hedging on firm value, as reported in Table 4. The results are in accordance with those reported in Table 3 with our governance index constructed using a simple linear combination of the eight variables but there are some differences. Both factors (PC_gov_board and PC_gov_audit) have positive and very significant coefficients in two hedging equations as reported in Panel A of Table 4 while the PC_gov-board variable is significant in the three equations. The hedge ratio has also a positive and very significant effect on both accounting firm value variables, as reported in Panel B of Table 4 but is not significant on Tobin's q value.

TABLE 4 – Simultaneous hedging and firm performance estimation: PCA analysis

	ROE	ROA	Tobin's Q
Panel A: The hedge ratio is the dependent variable			
<i>Firm_performance</i>	-0.195 (0.12)	-0.270 (0.74)	-0.050 (0.05)
<i>Ln(size)</i>	0.128*** (0.02)	0.122* (0.06)	0.137** (0.06)
<i>Market_to_book</i>	-0.049*** (0.02)	-0.046*** (0.00)	
<i>Leverage</i>	0.078 (0.05)	0.077 (0.10)	0.096* (0.05)
<i>Quick_ratio</i>	-0.009*** (0.00)	-0.008 (0.01)	-0.006* (0.00)
<i>Dividend_policy</i>	-0.018 (0.02)	-0.009 (0.02)	-0.006 (0.03)
<i>Tax_save</i>	0.216* (0.11)	0.218*** (0.06)	0.185* (0.10)
<i>CEO_CS</i>	0.114** (0.05)	0.116*** (0.04)	0.121*** (0.04)
<i>ValCEO_op</i>	-0.008*** (0.00)	-0.007** (0.00)	-0.007** (0.00)
<i>%_inst</i>	-0.647*** (0.09)	-0.616*** (0.04)	-0.603*** (0.14)
<i>CEO_age</i>	0.000 (0.00)	0.001*** (0.00)	0.001 (0.00)
<i>US_dummy</i>	0.605*** (0.11)	0.232*** (0.01)	0.241 (0.17)
<i>PC_gov_board</i>	0.023*** (0.00)	0.022*** (0.00)	0.021* (0.01)
<i>PC_gov_audit</i>	0.012*** (0.00)	0.011*** (0.00)	0.014 (0.01)
<i>Gold_price</i>	-0.000 (0.00)	-0.000*** (0.00)	-0.000 (0.00)
<i>Intercept</i>	-0.808*** (0.12)	-0.754* (0.39)	-0.865* (0.45)
Chi-2 (p-value)	1134.9 (0.00)	1159.3 (0.00)	1320.2 (0.00)
Observations	348	348	348

	ROE	ROA	Tobin's Q
Panel B: Firm performance is the dependent variable			
<i>Hedge_ratio</i>	0.463** (0.21)	0.183*** (0.05)	0.760 (0.72)
<i>Ln(size)</i>	-0.066* (0.04)	-0.063*** (0.01)	0.376* (0.21)
<i>Market_to_book</i>	-0.029 (0.05)	-0.001 (0.01)	
<i>Leverage</i>	-0.121 (0.08)	-0.090*** (0.02)	0.137 (0.15)
<i>Quick_ratio</i>	-0.008 (0.01)	0.000 (0.01)	-0.007 (0.02)
<i>Dividend_policy</i>	-0.023* (0.01)	-0.001 (0.00)	0.118 (0.10)
<i>Exploration</i>	1.631 (1.27)	-1.770 (3.28)	0.435 (2.20)
<i>Cash_cost</i>	-0.001** (0.00)	-0.000*** (0.00)	-0.002*** (0.00)
<i>%_inst</i>	-0.236 (0.21)	0.095 (0.06)	-1.678 (1.11)
<i>%_blockholders</i>	0.464** (0.19)	0.099 (0.08)	3.316*** (0.48)
<i>Maj_unr</i>	-0.016 (0.07)	0.017 (0.02)	-0.146 (0.11)
<i>CEO_age</i>	-0.007 (0.00)	-0.001 (0.00)	-0.005 (0.01)
<i>CEO_COB</i>	0.005 (0.13)	0.029*** (0.01)	-0.164** (0.08)
<i>CEO_tenure</i>	0.014*** (0.00)	0.002 (0.00)	0.023 (0.02)
<i>CEO_change</i>	0.023 (0.15)	0.013 (0.02)	-0.186*** (0.06)
<i>US_dummy</i>	-0.376 (0.28)	-0.181*** (0.04)	-0.920 (0.99)
<i>Gold_price</i>	0.002** (0.00)	0.000 (0.00)	0.010*** (0.00)
<i>Intercept</i>	0.538 (0.35)	0.376*** (0.12)	-2.919** (1.25)

	ROE	ROA	Tobin's Q
Chi-2 (p-value)	154.3 (0.00)	106.2 (0.00)	1811.4 (0.00)
Observations	348	348	348

Notes: This table reports the effect of having qualified and independent directors sitting on the board and the audit committee on the hedging behavior and performance of the firm. Panel A reports hedge ratio equation estimates and Panel B reports firm performance equation estimates. Governance quality is measured by two indexes: PC_gov_board (for the board) and PC_gov_audit (for the audit committee). Governance variable definitions are reported in Appendix B and results of PCA are presented in Appendix D. Simultaneous estimation of hedging and firm performance is made to account for endogeneity between the two dependent variables. The system is based on Zellner's SURE combined with a two-stage least squares estimation for each equation. The return on equity (ROE) and return on assets (ROA) measure the firm's accounting performance. Tobin's q measures firm market performance. All the regressions have firm effects and include a dummy variable for each quarter to control for seasonal effects in the data. The standard errors in parentheses were obtained from bootstrap analysis. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

5.4 High education and hedging

Firms that are engaged more in risk management could lean toward attracting educated directors, which brings up a potential endogeneity issue (Wintoki et al, 2012). To account for endogeneity issues, we simultaneously estimate the equation of the hedge ratio and that of high education (directors with a master's degree in finance or a PhD), using the two-stage least squares method for each equation. The control variables for the hedge ratio equation include variables of the first stage estimation, CEO age, CEO holdings in shares and options, and the percentage of institutional holdings. We also add the governance scores, accounting for the financial background of directors sitting on the board or the audit committee and the price of gold, which accounts for market movements. In the high education equation, the control variables include firm size, the market-to-book, and the percentage of institutional holdings. Additional independent variables include the cash fee paid for each meeting to outside directors, the annual fixed fee, the CEO's number of years of tenure, the average tenure on the board, the average age of the directors, and the number of options held by all directors.

In Panel A, our results show that a high level (High_Edu) of education affects significantly the hedging activity for directors sitting on the board and is insignificant for the audit committee (Table 5). The two governance indexes are positive and significant, suggesting that the high quality governance of the board and of the audit committee increases the level of risk management. Many control variables are significant and have the predicted sign. We also find that firms with high hedge ratios attract highly educated directors on both the audit committee and the board (Panel B). Since the Tax_save variable is not statistically significant in the hedging equation, we cannot conclude on any causality effect, however.

Table 5 – Simultaneous effects between hedging and high levels of education

	Audit	Board
Panel A: The hedge ratio is the dependent variable		
<i>High_Edu</i>	-0.039 (0.18)	0.186*** (0.05)
<i>Ln(size)</i>	0.110*** (0.01)	0.156 (0.14)
<i>Market_to_book</i>	-0.048 (0.03)	-0.025*** (0.00)
<i>Leverage</i>	0.105*** (0.04)	0.084*** (0.01)
<i>Quick_ratio</i>	-0.004 (0.01)	-0.007** (0.00)
<i>Dividend_policy</i>	-0.018* (0.01)	-0.005 (0.02)
<i>Tax_save</i>	0.157 (0.19)	0.212 (0.15)
<i>CEO_CS</i>	0.105*** (0.03)	0.082*** (0.01)
<i>ValCEO_op</i>	-0.006*** (0.00)	-0.005* (0.00)
<i>%_inst</i>	-0.571*** (0.11)	-0.515* (0.28)
<i>CEO_age</i>	-0.000 (0.00)	-0.000 (0.01)
<i>US_dummy</i>	2.315*** (0.48)	1.820** (0.77)
<i>Gov_index_aud</i>	0.072*** (0.03)	
<i>Gov_index_bor</i>		0.023*** (0.00)
<i>Gold_price</i>	-0.000 (0.00)	-0.000* (0.00)
<i>Intercept</i>	-2.715*** (0.65)	-2.400*** (0.81)
<i>Chi2 (p-value)</i>	1266.9 (0.00)	1154.2 (0.00)
<i>Observations</i>	343	343

	Audit	Board
Panel B: The high level of education is the dependent variable		
<i>Hedge_ratio</i>	1.114*** (0.01)	1.639*** (0.11)
<i>Ln(size)</i>	-0.448*** (0.09)	-0.362 (0.31)
<i>Market_to_book</i>	0.263*** (0.01)	-0.064* (0.03)
<i>%_inst</i>	-0.118*** (0.01)	0.208 (0.50)
<i>Cash_fee_outsiders</i>	-0.000 (0.00)	-0.000* (0.00)
<i>Annual_fixed_fee</i>	0.000*** (0.00)	0.000** (0.00)
<i>CEO_tenure</i>	-0.020*** (0.00)	-0.078*** (0.00)
<i>Average_tenure</i>	-0.020* (0.01)	0.083*** (0.01)
<i>Average_age</i>	0.001 (0.01)	0.001 (0.06)
<i>ValAll_opt</i>	0.000*** (0.00)	-0.000*** (0.00)
<i>Intercept</i>	0.275 (0.58)	-2.319 (3.29)
<i>Chi2 (p-value)</i>	1583.2 (0.00)	1947.3 (0.00)
<i>Observations</i>	343	343

Notes: This table reports the results of the simultaneous estimation of hedging and directors' high levels of education. Panel A reports estimates of the hedge ratio equation and Panel B reports estimates of the equation for directors' high levels of education. The system is based on Zellner's seemingly unrelated regression estimation (SURE) combined with a two-stage least squares estimation for each equation. All regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. Standard errors in parentheses were obtained from bootstrap analysis. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

5.5 Educated hedging against shocks to gold prices

The main goal of risk management in the gold mining industry is to hedge gold production against unpredictable changes in the price of gold. The question is whether firms with financially educated directors make better hedging decisions than the average of the industry. To analyze this

question, we measure educated hedging as the difference between i) the average hedge ratio of firms with educated directors and ii) the average hedge ratio of all firms (industry average). Our test focuses on examining the first movers when the price of gold starts downshifting. To model shifts in gold price, we use the regime shift detection technique of Maalaoui Chun et al (2014) to detect in real time significant shifts in the price of gold. Detected shifts are significant if the change in the price of gold is higher than two standard deviations of the price of gold. We choose to use this detection method because it enables us to identify shifts out of sample as opposed to in-sample detection using a Markov switching regime technique. Another advantage of this detection technique is being parameter free and not requiring initial hypotheses. It also separates shifts in level from shifts in volatility. We use daily gold prices observed during the period of analysis and confirm that a shift has occurred if the confidence level is 95% or higher. The most significant shift is detected in the first quarter of 1997 where the price of gold dropped by more than 20%. We use this shift to examine the behavior of educated hedging following unexpected shifts in gold price relative to the industry average. We also test the interaction between educated board members and gold price regime shifts.

Our results in Table 6 show that the marginal effect of educated board members (*%_Educated_board_members*) is significantly positive (a regression coefficient of 0.827, significant at the 1% confidence level) to explain educated hedging. This means that firms with educated directors are the first movers in hedging against gold prices. More interestingly, during low gold price regimes (*Regime_gold_price*), the interaction coefficient of *%_Educated_board_members* × *Regime_gold_price* is even higher (a regression coefficient of $2.075 = (0.827+1.248)$, significant at 5%). These results seem to confirm that firms with a high percentage of educated directors hedge more rapidly, especially when gold prices are low. The fact that educated hedging is higher during low gold price regimes seems to further suggest that educated hedging is based on earlier predictions of the movement of the gold price, since firms plan hedge activity before the gold price shift occurs.

TABLE 6 – Educated hedging following shocks to the gold price

Variable	Coefficient
<i>Ln(size)</i>	-0.100 (0.08)
<i>CEO_CS</i>	0.091 (0.12)
<i>ValCEO_op</i>	0.050*** (0.01)
<i>%_inst</i>	0.558 (0.36)
<i>CEO_age</i>	-0.002 (0.00)

Variable	Coefficient
<i>Maj_unr_bor</i>	-0.008 (0.04)
<i>%_Educated_board_members</i>	0.827*** (0.26)
<i>Regime_gold_price</i>	-0.104** (0.05)
<i>%_Educated_board_members</i> × <i>Regime_gold_price</i>	1.248** (0.49)
<i>Intercept</i>	0.370 (0.62)
Adj <i>R</i> -Squared	0.349
<i>F</i> -Value (<i>p</i> -value)	42.48 (0.00)
Observations	326

Notes: This table reports the results on the relation between educated hedging and shocks to the gold price. We model gold price shocks using the regime shift detection of significant changes (two standard deviations) in gold prices. Educated hedging is measured as the difference between the average hedge ratio of firms with educated directors minus the average hedge ratio of all firms in the industry. The regression includes firm fixed effects and a dummy variable for each quarter to control for seasonal effects in the data. Robust standard errors are in parentheses. The superscripts *** and ** denote significance at the 1% and 5% levels, respectively.

6. Risk management and governance: SOX and NYSE regulation

We now focus on the policy implications of the testable hypotheses. Even though the independence and accounting knowledge of directors are accounted for in the current regulation of nonfinancial institutions, it is not clear that these rules are achieving the goal of the regulation. The 2002 regulators have left the notion of financial literacy open to firm interpretation and the concept is rather vague without an explicit regulatory requirement for the financial knowledge of board members. During the 2007 financial crisis, it became clear that board members were missing the necessary knowledge to understand the complexity of the financial markets and necessary amendments to current regulations are still needed in the nonfinancial sector. Although the regulation requires that at least one member of the audit committee has an accounting background, this requirement does not seem to have been very effective during the crisis.

We test the effect of the SOX and NYSE regulations on risk management activities in Table 7. As explanatory variables in the hedging equation, we add the variables measuring each of the corresponding rules. We construct six compliance indexes: two for SOX rules, two for NYSE rules, and two indexes for both rules (see Appendix B for definitions). For each set of rules, we add

the variables measuring each of these rules. We report here results with additive SOX and NYSE rules. Other results are in Dionne et al (2018).

To test the effect of the regulations on firm performance, we use a model of simultaneous equations, thus addressing endogeneity issues. The results in Table 7 show that the SOX compliance index always has a positive effect on hedging activities; however, the NYSE compliance index based only on independence is not significant. We find that the positive effect of hedging is not strongly transmitted to shareholders since we do not find that risk management (*Hedge_ratio*) has any significant effect on firm performance, with the exception of a 5% limit level of significance for the ROE equation.

TABLE 7 – Simultaneous estimation of hedging and firm performance under SOX and NYSE regulations

	ROE	ROA	Tobin's Q
Panel A: The hedge ratio is the dependent variable			
<i>Firm_performance</i>	0.043 (0.11)	-0.366 (0.65)	0.001 (0.03)
<i>Ln(size)</i>	0.091*** (0.03)	0.081* (0.04)	0.076** (0.04)
<i>Market_to_book</i>	-0.031*** (0.01)	-0.035*** (0.01)	
<i>Leverage</i>	0.089*** (0.03)	0.057** (0.03)	0.079*** (0.02)
<i>Quick_ratio</i>	-0.006** (0.00)	-0.007 (0.01)	-0.006 (0.01)
<i>Dividend_policy</i>	-0.001 (0.01)	-0.002 (0.02)	-0.005 (0.03)
<i>Tax_save</i>	0.196* (0.11)	0.215 (0.18)	0.190*** (0.05)
<i>CEO_CS</i>	0.091*** (0.02)	0.106*** (0.03)	0.100*** (0.03)
<i>ValCEO_op</i>	-0.006*** (0.00)	-0.006*** (0.00)	-0.007*** (0.00)
<i>%_inst</i>	-0.686*** (0.20)	-0.675*** (0.19)	-0.687*** (0.18)
<i>CEO_age</i>	-0.000 (0.00)	-0.000 (0.00)	-0.000 (0.00)
<i>US_dummy</i>	0.227*** (0.06)	0.498*** (0.16)	0.523*** (0.16)
<i>Compliance_SOX1</i>	0.081*** (0.01)	0.074*** (0.02)	0.084** (0.03)

	ROE	ROA	Tobin's Q
<i>Compliance_NYSE1</i>	0.016 (0.01)	0.025 (0.02)	0.024 (0.02)
<i>Gold_price</i>	-0.000* (0.00)	-0.000 (0.00)	-0.001** (0.00)
<i>Intercept</i>	-0.656*** (0.15)	-0.603* (0.32)	-0.546 (0.40)
Chi-2 (p-value)	1323.3 (0.00)	1336.4 (0.00)	1314.3 (0.00)
Observations	348	348	348

Panel B: Firm performance is the dependent variable

<i>Hedge_ratio</i>	0.337** (0.16)	0.149 (0.11)	0.386 (0.44)
<i>Ln(size)</i>	-0.052 (0.05)	-0.059** (0.03)	0.420*** (0.08)
<i>Market_to_book</i>	-0.032 (0.05)	-0.002 (0.01)	
<i>Leverage</i>	-0.111 (0.08)	-0.088** (0.04)	0.163** (0.07)
<i>Quick_ratio</i>	-0.009*** (0.00)	0.000 (0.00)	-0.008 (0.02)
<i>Dividend_policy</i>	-0.026 (0.02)	-0.001 (0.01)	0.120 (0.08)
<i>Exploration</i>	1.642 (2.85)	-1.755 (3.93)	0.543 (2.63)
<i>Cash_cost</i>	-0.001*** (0.00)	-0.000 (0.00)	-0.002*** (0.00)
<i>%_inst</i>	-0.310** (0.14)	0.070 (0.18)	-1.800*** (0.48)
<i>%_blockholders</i>	0.466*** (0.15)	0.103 (0.06)	3.175*** (0.37)
<i>Tot_indep_aud</i>	-0.068 (0.11)	0.017 (0.02)	-0.159 (0.12)
<i>CEO_age</i>	-0.007 (0.00)	-0.001 (0.00)	-0.007 (0.01)
<i>CEO_COB</i>	0.020 (0.13)	0.022 (0.03)	-0.182* (0.10)
<i>CEO_tenure</i>	0.015* (0.01)	0.003 (0.00)	0.025*** (0.01)

	ROE	ROA	Tobin's Q
<i>CEO_change</i>	0.007 (0.12)	0.012 (0.03)	-0.204* (0.12)
<i>US_dummy</i>	-0.504 (0.32)	-0.168* (0.10)	-3.148*** (0.35)
<i>Gold_price</i>	0.002** (0.00)	0.000* (0.00)	0.010*** (0.00)
<i>Intercept</i>	0.576 (0.40)	0.368 (0.23)	-3.035*** (0.80)
Chi-2 (p-value)	156.3 (0.00)	109.0 (0.00)	1947.3 (0.00)
Observations	348	348	348

Notes: This table reports the results of the simultaneous estimation of hedging and firm performance to account for the endogeneity between the two variables. Panel A reports estimates of the hedge ratio equation and Panel B reports estimates of the firm performance equation. Two variables measure the 2002 changes in governance regulation: Compliance_SOX1 and Compliance_NYSE1. The system is based on Zellner's SURE combined with a two-stage least squares estimation for each equation. The return on equity (ROE) and the return on assets (ROA) measure firm accounting performance. The Tobin's q measures the firm's market performance. Governance variable definitions are reported in Appendix B. All regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. Standard errors in parentheses were obtained from bootstrap analysis. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

7. Effect of option holdings on risk management

Researchers have shown that conflicts of interest may arise between senior managers and shareholders regarding risk management, notably when officers are paid by stock options (Smith and Stulz, 1985; Tufano, 1996; Shue and Townsend, 2017).

Aside from the main objective of maximizing firm value, risk management can also maximize officers' welfare. However, this second objective may clash with the first and thus create governance problems, especially when executive compensation is heavily weighted in stock options. Tufano (1996) showed that executives in the North American gold production industry whose pay includes stock options invest much less in risk management than do other executives (also see Dionne and Triki (2013) who obtained similar results with updated data and different econometric specifications, and Rodgers (2002), who reached the same conclusion with a different database).

This result is explained by the fact that the value of executives' options increases with stock or firm value volatility. Even if managers are risk averse concerning their personal wealth, they may have convex preferences (that is, high risk tolerance) based on firm value when they hold stock options from the firm they run. They may consequently undertake fewer risk management

activities, because more risk management would reduce the volatility of firm value and hence the value of their options and the probability of exercising them, particularly when they are out of the money.

A theoretical counterargument was presented by Carpenter (2000). The author argues that holding options creates two consequences regarding senior managers' wealth. The first, described above, is that officer wealth increases with the volatility of the options held, particularly when options are out of the money. The second consequence is related to the fact that the value of the option portfolio may decrease proportionately with the total portfolio value or when the evaluation date is far away. We therefore have a theoretical arbitrage relationship, but the empirical results mentioned above seem to confirm the dominance of the convexity of manager preferences and the source of conflict of interest between executives and shareholders.

We obtain two important results in all our hedging equations (see Table 3 for example) in relation with the literature on hedging. They first confirm that CEOs with call options on the firm's shares hedge less (effect on hedging is always significantly negative), while those with shares hedge more (effect on hedging always significantly positive). Second, we find that more hedging increases the value of the firm. This suggests that when hedging decisions are motivated by the officers' interests instead of those of the shareholders, the call option result is a negative effect on the firm value. This result extends Tufano's (1996) contribution. Without an explicit empirical test, Tufano argues that hedging less to increase the volatility of share prices and the value of personal option holdings may have no consequences on firm value when hedging is costless. Our empirical results suggest that less hedging based on personal motives reduces the firm's value and thus becomes costly to shareholders. Still, this result should be stronger when options are out of the money.

We collected the strike prices from firms' proxy statements and corresponding share prices in the quarter the option was granted. We then computed the option's value and documented its moneyness. Among all options granted to officers, 66% were deeply out of the money, 26% were in the money and about 8% were at the money. These statistics support the prediction that officers with more option holdings hedge less to increase their option holding value. They are consistent with the conjecture which suggests that officers may have increased incentives to hedge less if their option holdings are out of the money. The results also support the need for better governance at the board and the audit committee with respect to this additional governance issue.

Conclusion: New rules since the financial crisis

In this research, we extend the analysis of corporate governance on hedging activity and firm value and construct governance indexes for the board and the audit committee accounting for independence, three dimensions of financial knowledge (education, experience, accounting background), and the chief executive officer (CEO)–board relationship. Our indexes have broader coverage than the SOX and NYSE compliance indexes and places more emphasis on the quality of

the directors on the boards and audit committee, measured by the degree of their financial sophistication as well as their independence. Our results strongly support the idea that sound corporate governance increases firm value. In our particular case, risk management is the channel through which corporate governance becomes effective and increases firm value. It is difficult, however, to generalize our results to all firms and industries since our sample is small and our application is limited to only one industry. Many firms in different industries are not exposed to large risks, as in the gold mining industry (Guay and Kothari, 2003)

Since the 2007 financial crisis, several companies, particularly financial firms, approve and monitor their risks using means other than that of the audit committee, for example, with risk committees. In these cases, the audit committee is not required to be the sole entity responsible for risk assessment and management but must perform risk assessment procedures of the company including its internal control. In other words, the risk assessment processes that these firms have put in place must be generally reviewed by the audit committee, but all risk management activities do not need to be evaluated in detail by this committee.

Recently, American, Canadian, and European regulatory agencies adopted new governance rules concerning banks and insurance companies. The Canadian rules (2013) require these institutions to have a risk committee on their board, made up of independent members only. The rules also specify that for large institutions with sophisticated risk management policies, the members of this new committee must be competent. The notion of competence is now part of the Canadian guideline on corporate governance issued by the Office of the Superintendent of Financial Institutions (OSFI). This guideline, summarized in OSFI (2013), calls on all directors to play an effective role. Although their individual contributions may vary, competencies must be interpreted collectively. Accordingly, the board of directors must collectively form a “balanced set of competencies, expertise, skills, and experience”. OSFI is not asking each director to be competent solely in finance. Rather, the members’ collective competencies represent the combination of competencies from each board member. To evaluate these competencies, the guideline states that the board of directors must put in place an annual process to evaluate the effectiveness of its practices and to use external consultants as needed. In addition, directors must seek internal or external education opportunities in order to fully understand the risks that a federal financial institution takes.

On March 27, 2014, the Board of Governors of the U. S. Federal Reserve System promulgated Enhanced Prudential Standards (EPS) for large U.S. bank holding companies (BHCs) and foreign banking organizations (FBOs). BHCs with total consolidated assets of \$50 billion or more must have a distinct risk committee to oversee the risk management of the financial institution. The EPS rules require that the risk committee include at least one risk expert who has experience managing risk in line with the size and complexity of the organization.

The Office of the Comptroller of the Currency (OCC) has also analyzed risk management of large banking organizations following the financial crisis. On September 11, 2014, the OCC established new standards for the risk management of certain large banks. The OCC’s standards

emphasize independent risk management and require banks to establish a framework that manages and controls the bank's risk-taking.

Boards of directors for large financial institutions now have risk committees that help the board define the firm's risk appetite, formulate risk management strategies, oversee firm management using adequate and robust risk measures and put in place risk management control mechanisms. It would be preferable for pension funds, hedge funds, or investment funds managers to willingly adopt these governance rules to better protect their stockholders and clients.

One important aspect mentioned by Stulz (2014) is the fact that risk management audit differs from accounting statements audit. Accounting statement audits mainly have a compliance role. Risk management audits have a compliance role, but the risk committee must also evaluate whether the current risk management policy, although compliant, maximizes the firm's value. This distinction justifies the creation of two distinct committees (audit and risk) in large financial institutions and in nonfinancial institutions with high risk exposure. It also justifies the need for having independent members on both committees that have sufficient financial knowledge to accomplish their dual role.

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Appendix A: Data sources

We hand collected the information on directors education and background using various sources that we may classify into two categories.

A.1 Publications

- The international who's who
- Who's who in Canada
- Who's who in America
- The S&P register of corporations, directors and executives
- Who's who in Canadian business
- Who's who in finance
- The Northern Miner
- Who's who in finance and industry
- The Financial Post directory of directors
- Who's who in Canadian finance
- The blue book of Canadian business
- Who's who in Ontario
- Encyclopedia of British Columbia
- Who's who in British Columbia
- Who's who in Australia
- Who's who in the West
- Who's who in the South and Southwest

A.2 Electronic sources

- Firms websites available in the internet and google search engine
- Proquest ABI/Inform
- Factiva provided by Reuters
- EDGAR online
- Lexis-Nexis
- Eureka.cc
- ACC

Appendix B: Details on the construction of the governance indexes

Measuring governance standards

- For the audit committee, the following dummy variables were constructed:

A1=1 if the audit committee is entirely composed of independent directors, and 0 otherwise.

A2=1 if the audit committee contains at least three members, and 0 otherwise.

A3=1 if the average tenure in the audit committee for directors is superior to 10 years, and 0 otherwise.

A4=1 if at least 25% of the audit committee hold a Master's degree or a Ph. D. in finance, and 0 otherwise.

A5=1 if each member of the audit committee is financially literate, and 0 otherwise.

A6=1 if the majority of the audit committee is comprised of financially active directors, and 0 otherwise.

A7=1 if the majority of the audit committee is comprised of financially educated directors, and 0 otherwise.

A8=1 if the majority of the audit committee is comprised of directors with accounting background, and 0 otherwise.

A9=1 if at least one director in the audit committee is considered financially knowledgeable, and 0 otherwise.

A10=1 if at least one director in the audit committee has an accounting background, and 0 otherwise.

- For the board, the following variables were constructed:

B1=1 if the majority of directors in the board are independent, and 0 otherwise.

B2=1 if the CEO is the COB, and 0 otherwise.

B3=1 if the average tenure of directors in the board is superior to 10 years, and 0 otherwise.

B4=1 if at least 25% of directors in the board hold a Master's or a Ph. D. in finance, and 0 otherwise.

B5=1 if the majority of directors in the board are considered financially knowledgeable, and 0 otherwise.

B6=1 if at least 25% of directors in the board are financially active, and 0 otherwise.

B7=1 if at least 25% of directors in the board are financially educated, and 0 otherwise.

B8=1 if at least 25% of directors in the board have an accounting background, and 0 otherwise.

The quality of the audit committee

- For the audit committee, our index requires the independence of directors and gives a higher score to audit committees comprised of directors with different levels and types of financial knowledge.

$$\text{Gov_index_audit} = A1 + A2 - A3 + A4 + A5 + A6 + A7 + A8.$$

The quality of the board

- Similarly, the following score index for the board was constructed.

$$\text{Gov_index_board} = B1 - B2 - B3 + B4 + B5 + B6 + B7 + B8$$

SOX standards

- Two compliance indexes to measure the SOX standards were constructed.

$$\text{Compliance_SOX1} = A1 + A9,$$

or

$$\text{Compliance_SOX2} = A1 \times A9.$$

NYSE standards

- Two compliance indexes to measure the NYSE standards were also constructed as follows.

$$\text{Compliance_NYSE1} = B1 + A2 + A5 + A10,$$

or

$$\text{Compliance_NYSE2} = B1 \times A2 \times A5 \times A10.$$

SOX and NYSE standards

- To obtain the compliance index to both SOX and NYSE standards, the following two variables were constructed.

$$\text{Compliance_SOX1_NYSE1} = A1 + A9 + B1 + A2 + A5 + A10,$$

or

$$\text{Compliance_SOX2_NYSE2} = A1 \times A9 \times B1 \times A2 \times A5 \times A10.$$

Appendix C: Variables

TABLE C.1 – Variables definitions

Panel A: General characteristics of the firm and the market	
<i>Hedge_ratio</i>	Delta of the risk management portfolio held by the firm divided by its expected production. The variable is measured at the quarter end.
<i>Ln(size)</i>	Market value of assets defined as the number of common shares outstanding multiplied by the end-of-year price per share plus the book value of assets minus the book value of equity. We use the logarithm of the firm size.
<i>Market_to_book</i>	Market value of total assets divided by the book value of assets.
<i>Leverage</i>	Total debt divided by the total of common equity plus preferred stocks.
<i>Quick_ratio</i>	Value of the cash on hand, short term investments and clients' accounts divided by the short-term liabilities.
<i>Dividend_policy</i>	Dummy variable equal to 1 if a firm pays cash dividends, and 0 otherwise.
<i>Tax_save</i>	Expected percentage savings in tax arising from a 5% drop in the volatility of taxable income (more details in Appendix B). The computation is based on annual data. To obtain quarterly data, we assume the same value of tax advantages during the four quarters of the year.
<i>US_dummy</i>	Dummy variable equal to 1 if the firm is a US firm, and 0 otherwise.
<i>%_inst</i>	Percentage of shares held by institutions.
<i>%_blockholders</i>	Percentage of shares held by blockholders (i.e. a non-managerial shareholder holding more than 10% of the firm's shares, Tufano, 1996).
<i>Exploration</i>	Firm exploration expenditures scaled the firm market value.
<i>Cash_cost</i>	Operating cost of producing one ounce of gold, excluding all non-cash items such as depreciation, amortization and other financial costs.
<i>Gold_price</i>	Price of one ounce of gold in the spot market.
<i>CEO_age</i>	Age of the CEO (years).
<i>CEO_tenure</i>	Dummy variable equal to 1 if the CEO is tenured as CEO, and 0 otherwise.
<i>CEO_COB</i>	Dummy variable equal to 1 if the CEO is the chairman of the board, and 0 otherwise.

<i>CEO_change</i>	Dummy variable equal to 1 if the CEO changed during the year, and 0 otherwise.
<i>CEO_CS</i>	Net value of the firm's common shares held by the CEO (millions, USD).
<i>ValCEO_Op</i>	Value of exercisable options held by the CEO (millions, USD).
<i>ValAll_Op</i>	Value of exercisable options held by all directors (millions, USD).
<i>Cash_fee_outsiders</i>	Cash fee paid for each meeting to outside directors (thousands, USD).
<i>Annual_fixed_fee</i>	Annual fixed fee paid for each meeting to outside directors (thousands, USD).
<i>CEO_Bachelor</i>	Dummy variable equal to 1 if the CEO has a Bachelor's degree in finance, and 0 otherwise.
<i>CEO_High_Edu</i>	Dummy variable equal to 1 if the CEO has a Master's degree or a PhD in finance, and 0 otherwise.

Panel B: General characteristics of directors and CEOs

<i>CEO_age</i>	Age of the CEO (years).
<i>CEO_tenure</i>	Dummy variable equal to one if the CEO is tenure as CEO, and zero otherwise.
<i>CEO_COB</i>	Dummy variable equal to one if the CEO is the chairman of the board, and zero otherwise.
<i>CEO_change</i>	Dummy variable equal to one if the CEO changed during the year, and zero otherwise.
<i>CEO_CS</i>	Net value of the common shares of the firm held by the CEO (millions, USD).
<i>ValCEO_Op</i>	Value of exercisable options held by the CEO (millions, USD).
<i>ValAll_Op</i>	Value of exercisable options held by all directors (millions, USD).
<i>Cash_fee_outsiders</i>	Cash fee paid for each meeting to outside directors (thousands, USD).
<i>Annual_fixed_fee</i>	Annual fixed fee paid for each meeting to outside directors (thousands, USD).
<i>CEO_Bachelor</i>	Dummy variable equal to one if the CEO has a bachelor degree in finance and zero otherwise.
<i>CEO_High_Edu</i>	Dummy variable equal to one if the CEO has a Master degree or a PhD in finance and zero otherwise.

Panel C: Characteristics and financial background of directors

<i>Min_size</i>	Dummy variable equal to one if there is a minimum of three directors sitting on the audit committee, and zero otherwise.
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<i>Tot_indep</i>	Dummy variable equal to one if all directors sitting on the audit committee are unrelated directors, and zero otherwise.
<i>Maj_indep</i>	Dummy variable equal to one if the majority of directors sitting on the board are unrelated, and zero otherwise.
<i>%_indep</i>	Proportion of unrelated directors sitting on the board. We divide the number of unrelated directors by the size of the board.
<i>I_Fin_know</i>	Dummy variable equal to one if at least one (i=One) or all (i=All) director sitting on the audit committee are financially literate, and zero otherwise.
<i>I_Act_Edu_Acc</i>	Dummy variable equal to one if <i>i</i> director(s) sitting on the audit committee or the board are financially active, educated, and have an accounting background, and zero otherwise.
<i>I_Act_Edu_NotAcc</i>	Dummy variable equal to one if <i>i</i> director(s) sitting on the audit committee or the board are financially active, educated, and do not have an accounting background, and zero otherwise.
<i>I_Act_NotEdu_NotAcc</i>	Dummy variable equal to one if <i>i</i> director(s) sitting on the audit committee or the board are financially active, but are not financially educated, and do not have an accounting background, and zero otherwise.
<i>I_NotAct_Edu_Acc</i>	Dummy variable equal to one if <i>i</i> director(s) sitting on the audit committee or the board are not financially active, but are educated, and have an accounting background, and zero otherwise.
<i>I_NotAct_Edu_NotAcc</i>	Dummy variable equal to one if <i>i</i> director(s) sitting on the audit committee or the board are educated, but are not financially active, and do not have an accounting background, and zero otherwise.
<i>%_Bachelor</i>	Percentage of directors sitting on the board or the audit committee with a Bachelor degree.
<i>%_High_Edu</i>	Percentage of directors sitting on the board or the audit committee with a Master or a PhD degree. The percentage is relative to the size of the committee.
<i>Num_High_Edu</i>	Number of directors sitting on the board or the audit committee with a Master or a PhD degree.
<i>I_Acc</i>	Dummy variable equal to one if <i>i</i> director(s) sitting on the board or the audit committee have an accounting background, and zero otherwise.

Appendix D: PCA results

TABLE D.1 – Principal component analysis on governance variables

Panel A: Principal component for variables of the audit								
Variable	C1	C2	C3	C4	C5	C6	C7	C8
A1	0.30	0.20	-0.39	-0.45	0.08	0.71	0.02	-0.04
A2	-0.18	0.35	0.42	0.44	0.55	0.42	0.03	-0.03
A3	0.53	-0.11	0.05	0.34	-0.09	0.10	-0.59	0.47
A4	0.22	-0.18	0.42	-0.59	0.52	-0.22	0.02	0.26
A5	0.39	-0.15	-0.44	0.27	0.54	-0.28	0.01	-0.43
A6	0.34	-0.51	0.24	0.23	-0.16	0.27	0.64	0.02
A7	0.43	0.32	0.48	-0.10	-0.30	-0.08	-0.13	-0.60
A8	0.31	0.64	-0.13	0.09	-0.04	-0.31	0.47	0.40
Panel B: Principal component for variables of the board								
Variable	C1	C2	C3	C4	C5	C6	C7	C8
B1	0.008	-0.43	-0.21	0.74	0.04	-0.07	0.43	0.17
B2	0.02	-0.06	0.56	-0.05	0.79	-0.06	0.16	0.14
B3	-0.51	0.48	0.00	0.07	-0.09	0.28	0.28	0.58
B4	0.53	0.14	-0.45	-0.14	0.24	-0.17	-0.23	0.58
B5	0.27	0.40	0.19	0.58	0.07	0.42	-0.44	-0.14
B6	0.23	0.42	0.37	0.16	-0.33	-0.68	0.19	0.03
B7	0.52	0.21	-0.03	-0.23	-0.05	0.43	0.64	-0.21
B8	0.24	-0.43	0.51	-0.11	-0.44	0.26	-0.13	0.45

Notes: The table reports the weights of the governance variable (A1 to A8 for the audit committee, Panel A and B1 to B8 for the board, Panel B) comprising each of the principal factors C1 to C8. The retained first factor C1 explains 47% of the total variance of audit committee governance variables and 37% of the total variance of board governance variables.