Hedging, speculation and shareholder value

Tim R. Adam
Department of Finance
Hong Kong University of Science and Technology
Clear Water Bay, Kowloon
Hong Kong
Tel.: (852) 2358-7675
Fax: (852) 2358-1749
E-mail: *adam@ust.hk*

Chitru S. Fernando*
Michael F. Price College of Business
University of Oklahoma
307 West Brooks, Room 205
Norman, OK 73019, USA
Tel.: (405) 325-2906
Fax: (405) 325-7688
E-mail: *cfernando@ou.edu*

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*Corresponding author.

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Abstract

We examine a common assumption in the risk management literature, that derivatives transactions have zero intrinsic net worth, and add value only because they help firms mitigate market imperfections by hedging financial risk. For a sample of 92 North American gold mining firms we infer the quarterly cash flows that each firm derives specifically from its derivatives transactions. We find that these derivatives cash flows are significantly positive on average, both economically and statistically. These positive derivatives cash flows appear to translate into increases in shareholder value, since we find no evidence of an upward adjustment of firms' systematic risk to offset the cash flow gains. The bulk of the gains appear to be the result of forward prices generally exceeding realized future spot prices in the gold market. Consistent with anecdotal evidence on selective hedging, we find that hedge ratios and derivatives cash flows are too volatile to be explained purely by changes in firms' hedging fundamentals. However, the gains from selective hedging are small at best. To our knowledge, this is the first study to show that corporate derivatives use can be intrinsically valuable. Our results highlight a potentially important motive for the corporate use of derivatives that the literature has hitherto ignored, and have implications for the measurement of hedging benefits.

The company recognizes that opportunities may exist to improve spot exchange rates as well as gold and silver spot prices through hedging. -- Placer Pacific Limited, Annual Report 1996.

We won't hedge our gold reserves! We believe gold prices are going to rise! -- Franco-Nevada, Annual Report 1999.

The above statements are puzzling because the existing theories of corporate hedging assume that the use of derivatives by itself does not increase a firm's value. Rather, the use of derivatives is thought to add value by alleviating a variety of market imperfections through hedging.[1] Why then do some firms claim that "hedging" (as in the case of Placer Pacific) or "not hedging" (as in the case of Franco-Nevada) can directly enhance their revenues? It is possible that managers believe that they can create value for shareholders by incorporating speculative elements into their hedging programs.[2] However, this issue has received little attention in the academic literature, possibly due to a lack of adequate firm-specific data on derivatives usage.

We address the question of whether corporate derivatives use is intrinsically valuable by utilizing a unique database that contains quarterly observations on all outstanding gold

[1] Theoretical models of corporate hedging have been built on the assumption that hedging benefits arise solely from the alleviation of market imperfections such as taxes, bankruptcy costs, financing constraints, agency costs, and undiversified stakeholders. See Stulz (1984), Smith and Stulz (1985), Stulz (1990), Froot, Scharfstein and Stein (1993), DeMarzo and Duffie (1995), and Mello and Parsons (2000) for further discussion on the theoretical motives for hedging.

[2] Several studies have documented that managers incorporate market views into their hedging programs. See, for example, Dolde (1993), Bodnar, Hayt and Marston (1998), and Adam (2000).

derivatives positions of a sample of 92 North American gold mining firms from 1989-1999.[3] This data allows us to infer and analyze the actual cash flows that stem from each firm's derivatives transactions on a quarterly basis over a 10-year period. We compare the actual cash flows with benchmarks to determine whether firms are making or losing money using derivatives, and what the sources of these gains or losses are.

We find that the firms in our study generate positive cash flows that are highly significant both economically and statistically. They are statistically significant in both rising and falling markets. Our sample firms realize an average total cash flow gain of \$11 million or \$24 per ounce of gold hedged per year, while the average net income is only \$3.5 million. The bulk of the cash flow gain appears to stem from persistent positive spreads between forward prices and realized future spot prices in the gold market, i.e. positive realized risk premia.[4] We find no evidence that the use of derivatives increases the systematic risk for the firms in our sample, which implies that their derivatives transactions increase shareholder value.

Furthermore, we find considerable excess volatility in firms' hedge ratios over time, and record anecdotal evidence that firms incorporate their market views into their hedging

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[3] Hedging activity in the gold mining industry has been extensively studied in the literature. See, for example, Tufano (1996, 1998), Shimko and McDonald (1997), Petersen and Thiagarajan (2000), Chidambaran, Fernando and Spindt (2001) and Adam (2003). Tufano's 1991-1993 dataset and our 1989-1999 dataset share a common source: the quarterly survey conducted by Ted Reeve, an analyst at Scotia McLeod, of outstanding gold derivatives positions at major North American gold mining firms. The data set contains information on all outstanding gold derivatives positions, their size and direction, the instrument types, maturities, and the respective delivery prices for each instrument.

[4] Keynes (1930) calls the difference between the forward price and the future spot price the "risk premium." It represents the compensation for risk that is paid by hedgers to speculators. See for example Hansen and Hodrick (1980), Hsieh and Kulatilaka (1982), Fama and French (1987), Hirshleifer (1989, 1990), Bessembinder (1992), Bessembinder and Chan (1992), and Linn and Stanhouse (2002) for evidence on the existence of risk premia. The risk premium is different from the "basis" (see Fama and French (1987)) which is the spread between the forward price and the current spot price. Thus, while the basis is currently observable, the risk premium is not. Some authors use the term "contango" ("backwardation") to refer to a positive (negative) basis while others use these same terms to refer to a positive (negative) risk premium.

programs.[5] Stulz (1996) refers to this type of speculation as "selective hedging." However, we find that the average cash flow gains from such speculative behavior are small at best.

We make several contributions to the risk management literature. First, we show that a central tenet of hedging theory, i.e. that derivatives transactions by themselves do not produce positive cash flows and create value on average, can be violated for an extended period. Second, we highlight that risk premia in the derivatives markets can be a potentially important motive for the corporate use of derivatives. Third, we show that the benefits from hedging selectively are small at best. Finally, our analysis implies that disregarding the intrinsic cash flow effects of derivatives usage will lead to an erroneous measurement of the hedging benefits that arise from the alleviation of market imperfections.

Our work is related to a recent study by Brown, Crabb and Haushalter (2002), who find evidence of selective hedging in a sample of 48 firms drawn from three industries (including 44 gold producers). Consistent with our results they find that the potential economic benefit of selective hedging in their sample is quite small. However, Brown, Crabb and Haushalter (2002) do not measure the total cash flow effects of derivatives use as we do. We show that gold producers who sold gold forward benefited handsomely from a persistent positive risk premium in the gold market, despite their lack of success in selective hedging. While continually selling forward is a risky strategy for pure speculators, gold mining firms have a comparative advantage in capturing the benefits of a positive risk premium. This is due to their inherent long position in gold (their gold reserves). Nonetheless, to the extent that risk premia in the gold market are attributable to systematic risk in gold prices, theory would dictate that a firm's systematic risk should be adjusted upwards to offset any positive cash

[5] Stulz (1996), Graham and Harvey (2001), Baker and Wurgler (2002), Brown, Crabb and Haushalter (2002), and Naik and Yadav (2002) discuss corporate decision making based on market views.

flows that it earns from these risk premia. Surprisingly, we find no evidence of such an adjustment.

Our work is also related to a recent study by Hentschel and Kothari (2001), who examine whether firms hedge or speculate by using derivatives. They find few, if any, measurable differences in risk exposures between firms that use derivatives and those that do not, and conclude that derivatives usage has no measurable impact on exposure or volatility. In contrast, the firms in our sample that employ derivatives reduce their one-year gold price exposures by 54% on average. Additionally, the average cash flow contribution earned solely from using derivatives (i.e. disregarding any beneficial effects due to reducing frictions) is more than three times their average net profit. Our results are consistent with the findings of Tufano (1998) who demonstrates a significant negative correlation between hedging and exposure.

Our findings are also relevant for empirical studies on why firms hedge. In particular, our findings contradict the standard theoretical view reflected in existing empirical studies that expected risk premia are zero and firms do not engage in selective hedging.[6] The implications of our research also flow over to studies undertaken to measure the impact of using derivatives. For example, Allayannis and Weston (2001) show that for a sample of 720 large non-financial firms, the use of foreign currency derivatives is positively related to firm value. Given our findings, it is not clear whether this value increase stems from the alleviation of market imperfections or from risk premia in forward markets, with or without selective hedging. Our methodology permits a separation of these components. Indeed, while our study

[6] See Tufano (1996), Géczy, Minton and Schrand (1997), Graham and Smith (1999), Brown (2001), and Graham and Rogers (2002) for empirical evidence on why firms hedge.

also reveals a positive relationship between a firm's cash flow gain and derivative usage, this relationship is completely unrelated to the *hedging* benefits of derivatives use.

Finally, our data set and methodology enable a more precise measurement of the impact of derivatives use by firms than has been possible hitherto. Allayannis and Mozumdar (2000) infer annual derivatives cash flows from income statements, relying on the footnotes to determine whether derivatives cash flows are allocated to sales, costs, or are reported separately. Unfortunately, this works only for a relatively small number of firms. Guay and Kothari (2002) use simulation analysis to estimate the cash flow impact of derivatives usage by non-financial firms and conclude that derivatives are likely to have only a modest impact. In contrast, we use quarterly observations on firms' derivatives positions to derive the actual cash flows that stem from firms' derivatives activities. A further novelty of our approach relative to previous studies lies in the fact that, due to the time-series nature of our data set, we can analyze the hedging behavior of each *individual* firm in our sample. The quarterly data on derivatives positions, together with gold price and other market data, can be used to track the quarterly gains and losses on the derivatives portfolios. While the hedge ratio gives a sense of whether a firm is hedging or speculating, we can also examine the cash flow impact on a firm's quarterly earnings, which permits a more precise measure of the effect of derivatives use than the stock market measure used by Hentschel and Kothari (2001).

The rest of our paper is organized as follows. In Section 2 we examine how the existence of risk premia might affect firms' hedging strategies and review the evidence on the presence of selective hedging. Section 3 describes the sample of gold mining firms that we use in our study and the data set employed in our analysis. Section 4 presents our evidence on the existence of selective hedging in our sample. Section 5 presents our findings on the cash flow and value gains from risk premia and selective hedging. Section 6 concludes.

2. Corporate hedging and speculation

The existing theory of corporate risk management assumes that firms use derivatives purely for hedging purposes, and that the benefits of derivatives usage accrue solely from the alleviation of market imperfections. These theories implicitly assume that the expected return of a derivatives portfolio is zero, which would be the case if, for example, the unbiased expectations hypothesis holds.[7] However, numerous studies have documented contrary evidence. Hansen and Hodrick (1980) find evidence that rejects the unbiased expectations hypothesis for seven major currencies both during the 1920s and also during the 1970s. Hsieh and Kulatilaka (1982) show that in markets for copper, tin, lead and zinc, forward prices are biased predictors of future spot prices. They further show that the expected risk premium in forward prices, which is the difference between forward prices and expected future spot prices, varies over time. In a study of 21 commodities including agricultural products, wood products, animal products and metals, Fama and French (1987) find evidence of time varying expected risk premia in five commodities: soy oil, lumber, cocoa, corn and wheat. In a study of 12 futures markets, including currencies (pound, yen, swiss franc and deutsche mark), metals (gold, silver, copper and platinum) and agricultural commodities (soy beans, wheat, cotton and cattle), Bessembinder and Chan (1992) show that risk premia in futures prices can be forecasted using three instrumental variables: treasury bill yields, equity dividend yields

[7] Under the unbiased expectations hypothesis the forward price is an unbiased predictor of the future spot price.

and the junk bond premium. They attribute this forecastability to time-varying risk premia in futures prices.

Risk premia in futures prices are attributed in the literature to hedging pressure, systematic risk, or a combination of the two. The hedging pressure view of risk premia, dating back to Keynes (1930) and Hicks (1939), is that hedgers pay risk premia to transfer their risk to speculators, causing futures prices to deviate from expected future spot prices. In contrast, the systematic risk theory argues that futures risk premia arise from undiversifiable risk in futures prices (see, for example, Dusak (1973) and Black (1976)). Stoll (1979) and Hirshleifer (1989, 1990) present models in which futures risk premia depend on both hedging pressure and systematic risk.

While the structural determinants of risk premia pertaining specifically to the gold market have not been examined to our knowledge, Shimko and McDonald (1997) present a novel rationale for why forward gold prices are higher than what they consider to be normal. Shimko and McDonald argue that the gold lending activities undertaken by central banks artificially depress the gold lease rates, and thereby cause an upward bias in forward prices. Since gold producers hedge by selling forward, central banks are indirectly subsidizing the hedging activities of gold producers.[8] Some of the hedging gains we document in this paper may indeed be due to this effect.

The above arguments show that firms may use derivatives not only for hedging purposes but also to benefit from persistent risk premia when they exist. In this case, derivatives add value not only by mitigating market imperfections, but also by generating

[8] We thank the referee for drawing our attention to this rationale for the gold risk premium.

positive cash flows on average.[9] Alternatively, even if firms use derivatives purely for hedging, the presence of risk premia could have unintended positive and negative consequences on cash flows and firm value. These possibilities have hitherto not been explored in the literature on corporate risk management.

In the next subsection, we review the existing evidence that firms incorporate speculative views in their hedging programs. Thereafter we examine in detail the sources of derivatives cash flow when we allow for the possibility of risk premia and corporate speculation.

2.1 Existing evidence on selective hedging

There is considerable survey evidence that managers' market views affect the risk management programs of many firms. In a survey of 244 Fortune 500 firms, Dolde (1993) reports that almost 90% of the firms surveyed at least sometimes based the size of their hedges on their views of future market movements. Bodnar, Hayt and Marston (1998) survey derivatives usage by 399 U.S. non-financial firms, and find that about 50% of their sample firms admit to sometimes (and 10% frequently) altering the size and/or the timing of a hedge based on their market views. Glaum (2002) surveys the risk management practices of the major non-financial firms in Germany. He finds that the majority follows forecast-based, profit-oriented risk management strategies.

There is also evidence that some degree of speculation is widespread in the gold mining industry. For example, in a survey of 13 gold mining firms by Adam (2000), eight

[9] It is important to note that an increase in derivatives cash flows will not automatically translate into an increase in shareholder value if the market upwardly revises its estimate of the firm's systematic risk to reflect its use of derivatives. We address this issue in our empirical analysis.

firms (62%) reported that their expectation about future metal prices is a very important or fairly important factor that determines the extent to which they hedge. Three firms (23%) stated that increasing sales revenue was the primary objective of their risk management programs. Brown, Crabb and Haushalter (2002) report that for a sample of 44 gold producers, managers' market views appear to have an impact on their hedging strategies. These findings are supported by anecdotal evidence that we have collected from corporate reports. The following extracts complement the two quotes we cite in Section 1.

> The company's primary strategy in managing risks associated with price and exchange rate movements is through operating cost containment but, where opportunities exist to improve upon spot prices and exchange rates, the company enters into hedge contracts. (**Kidston Gold Limited**, Annual Report 1998).

> As a low-cost producer, Prime can withstand price fluctuations. However, we view hedging as a vehicle to enhance our revenue over the long term. (**Prime Resources Group Inc**., Annual Report 1997).

These statements are consistent with the existence of a persistent risk premium in the gold market and the use of derivatives strategies to benefit from it. Additionally, companies may change their hedge ratios over time based on their market views. For example, Barrick Gold writes in its 1998 annual report, "The company is fully hedged for the next two years and 25% hedged on production for several years beyond 2001." In 2002, Barrick writes, "We are reducing … our (hedging) program, given … our positive view of the gold price."

It is important to note that a hedging strategy designed to capture benefits associated with the deviation of futures prices from spot prices is not without its own set of risks. The well-publicized derivatives-related loss at Metallgesellschaft AG (MG) is a case in point.[10] In 1992, MG's U.S. subsidiary, MG Refining and Marketing (MGRM) sold five- and ten-year delivery contracts for gasoline and other petroleum products. The resulting price exposure was hedged by purchasing a stack of one-month futures contracts equivalent to MGRM's total delivery obligations. At the end of each month, any outstanding futures contract was rolled forward into another one-month contract. An advantage of this "stack-and-roll" strategy was the persistently negative basis or "backwardation" in the oil market, i.e., forward prices that were persistently lower than current spot prices. This meant that at each roll-over date MGRM could book a roll-over gain if the backwardation continued to persist. However, the collapse of oil prices in September 1993 had two negative effects for MGRM. First, the basis reversed from backwardation to contango, replacing the previous gains from rolling with losses. Second, the plunge in oil prices triggered substantial margin calls. Since the revenue from the underlying delivery contracts could not be booked until many years later, MGRM faced a liquidity crisis. Instead of borrowing against the highly valuable delivery contracts, MGRM decided to liquidate the hedging program, and terminate the supply contracts at no cost to its customers. These decisions led to a loss of over $1 billion for MG's shareholders.

There are two significant differences between the hedging strategies of MGRM and the gold mining firms in our study. First, gold mining firms on average hedge substantially less than 100% of their planned future production. Second, gold mining firms tend to match the maturities of the hedge contracts with the planned gold production. These differences

[10] See Culp and Miller (1995) and Mello and Parsons (1995) for details about the Metallgesellschaft case. We thank the referee for drawing our attention to this episode.

make it less likely that gold mining firms will face the level of distress that MG encountered.[11]

2.2 The components of a firm's total derivatives cash flow

Consider a commodity producing firm that sells its output in a perfectly competitive market. Let *F(t,T)* be the forward price at time *t* for delivery of this commodity at time *T*. Let *S(t)* be the spot price at time *t*. The expected risk premium at time *t* can be expressed as:

$$E_t[R(t,T)] = F(t,T) - E_t[S(T)]$$

Suppose the firm sells a fraction *h* (the "hedge ratio") of its future production at the forward price *F(t,T)*. If the expected risk premium is zero, then the firm will choose a hedge ratio, h^{fund}, based purely on hedging fundamentals, because the forward contract itself has zero expected value. If $E_t[R(t,T)] > 0$, then the firm might decide to exploit the positive expected risk premium and choose a hedge ratio $h > h^{\text{fund}}$. Similarly, if $E_t[R(t,T)] < 0$, the firm might decide to choose a hedge ratio $h < h^{\text{fund}}$, because the forward contract has a negative expected value. Thus, when the firm adjusts its hedge ratio to benefit from the expected risk premium, *h* will increase monotonically with the expected risk premium.

To what extent can we empirically detect whether a firm adjusts its hedge ratio due to the existence of a risk premium? Suppose that the expected risk premium is constant over time. In this case a firm will adjust its hedge ratio only in response to changes in fundamentals. A constant positive expected risk premium will simply induce a constant

[11] Nonetheless, in 1999, Ashanti Goldfields and Cambior were hit by margin calls because the losses of their hedge books exceeded the lines of credit with their bankers. Both companies maintained unusually large hedge positions, and thus faced a credit squeeze similar to MG.

upward bias in the firm's hedge ratio. Such a constant bias would not be detectable empirically.

If the expected risk premium is time-variable, however, a firm may hedge selectively based on its view about the risk premium. This will again bias its hedge ratios, but this time the bias will be time-variable. Thus, volatility of a firm's hedge ratios will exceed levels that fundamentals alone can explain. This excess volatility is empirically detectable. Thus, we can separate hedge ratios and the associated derivatives cash flows into two empirically identifiable components:

A. a component attributable to hedging fundamentals, plus any constant bias due to the constant component of the expected risk premium; and

B. a component attributable to the time-varying component of the expected risk premium, or changes in the firm's market views (*selective hedging*).

We refer to "A" as the *predicted hedge cash flow*, and "B" as the *selective hedge cash flow*. Under the null hypothesis of zero risk premia, the predicted hedge cash flow would not be significantly different from zero. Significantly positive selective hedge cash flows would provide evidence that firms are successful at selective hedging, even when risk premia are zero on average.

3. Data

The sample consists of 92 gold mining firms in North America and encompasses the majority of firms in the gold mining industry. This sample consists of the firms covered by the *Gold and Silver Hedge Outlook*, a quarterly survey conducted by Ted Reeve, an analyst at Scotia McLeod, from 1989 to 1999. Firms that were not included in the survey tended to be small or privately held corporations. We provide a listing of the firms in our sample in Appendix A.

The survey data set contains information on all outstanding gold derivatives positions, their size and direction, maturities, and the respective delivery prices for each instrument for our sample of firms. The derivatives portfolios consist of forward instruments (forwards, spot-deferred contracts[12] and gold loans) and options (put and call). There are a total of 2541 firm-quarter observations of which 1450 firm-quarters represent non-zero hedging portfolios. Appendix B provides an example of the raw data.

Our data permits us to calculate the net cash flow associated with each derivatives transaction for each firm. A detailed description of how we perform these calculations is provided in Appendix C. The calculations require information on gold spot and futures prices, interest rates, and the gold lease rate. Daily gold spot prices and gold futures prices are obtained from Datastream. Daily Treasury constant maturity interest rates (1-month to 7-year) are from the Federal Reserve Statistical Release H.15. The gold lease rate has been provided by Scotia McLeod on a monthly basis until December 1996. The most recent figures are from Bloomberg.

Financial data is obtained from Compustat, and collected by hand from firms' financial statements if a firm is not covered by Compustat. Stock market return data is obtained from the CRSP database. Operational data, e.g. gold production figures, production costs per ounce of gold, etc. is collected by hand from firms' financial statements.

[12] A spot-deferred contract is similar to a forward contract except that delivery can be deferred at the discretion of the deliverer.

4. Analysis of hedge ratios

In this section, we examine the hedging behavior of our sample of firms for evidence of speculative activities. In particular, we analyze the time-series behavior of hedge ratios. The hedge ratio is defined as the fraction of the future expected gold production that has been sold forward. Since we have production forecasts available for up to five years, we calculate five hedge ratios, one for each forecast horizon. The five hedge ratios are defined as follows.

$$x-year \;\; hedge \;\; ratio = \frac{-Portfolio \;\; delta \;\; (x-year \;\; contracts)}{Expected \;\; production \;\; (x\, years \;\; ahead)},$$

where x = 1, 2, 3, 4, 5. The portfolio delta is the sum of the deltas of the individual derivatives positions, and the hedge ratio represents the fraction of the future gold production that has been hedged.[13] Table 1 provides descriptive statistics of the five hedge ratios, for all firms in the sample (Panel A), for all firms excluding firms that do not use any derivatives during a quarter (Panel B), and for firms that choose positive hedge ratios (Panel C).

[Place Table 1 about here]

In contrast to Hentschel and Kothari (2001), we find that the firms in our sample use derivatives extensively and by doing so, reduce their one-year exposures by 54% on average and longer-term exposures by around 25% on average (see Panel C). We observe that hedge ratios are highly volatile (Panel D). The one-year hedge ratio has an average volatility of 28%, while the five-year hedge ratio has an average volatility of 15%.[14]

[13] Tufano (1996) refers to this ratio as the "delta-percentage." Unlike in Tufano (1996) however, there is a potential bias that may arise in our analysis because we consider the time-series behavior of hedge ratios. When there are options in a portfolio, the hedge ratio tends to increase over time if the options are in-the-money, and tends to decrease over time if the options are out-of-the-money. It is difficult to predict the extent or direction of this bias. We carry out robustness checks, e.g., conduct the analysis without options positions, to control for this potential bias. We thank the referee for bringing this issue to our attention.

[14] Brown, Crabb and Haushalter (2002) also examine the time series volatility of the hedge ratios of 44 gold producers. They argue that the volatility is too high to be explained by changes in firms' financial or operating characteristics, and therefore attribute the excess volatility to selective hedging.

Figure 1 provides time series plots of the median hedge ratios. There is no apparent time trend in hedge ratios, despite some seasonality.[15] The volatility of the hedge ratios appears to be quite high, possibly too high to be explained by a pure hedging rationale.

[Place Figure 1 about here]

We use five different methodologies to capture the time variation in hedge ratios that is attributable to a hedging rationale. The first of these is based on the notion that pure hedgers vary their hedge ratios only in response to variation in fundamentals. We regress all five hedge ratios on variables that the literature has identified as being determinants of the extent to which firms hedge: firm size, the market-to-book ratio of assets, leverage, liquidity, dividend policy, and the existence of a credit rating.[16] We include dummy variables to control for the seasonality in the data. We estimate a Cragg (1971) two-stage model (see also Greene, 1993, p. 700) since firms typically make two sequential decisions pertaining to hedging: (a) to hedge or not to hedge; and (b) conditional on deciding to hedge, how much to hedge. The predicted values from these regressions form our estimates of hedge ratios under a hedging strategy that does not include selective hedging.[17] The results are provided in Table 2.

[Place Table 2 about here]

Panel A of Table 2 presents the descriptive statistics of the regressors for all firms in the sample. Panel B presents the second stage regression results of the Cragg model for the

[15] Hedge ratios tend to be lowest in the December surveys and highest in the September surveys. We control for this seasonality in the regressions that follow.

[16] See Haushalter (2000) for a discussion of the rationales for using these variables. It is possible that some of the variables that determine a firm's hedging policy, such as size, could also drive selective hedging behavior (see Stulz, 1996). We thank the referee for drawing our attention to this point. We use the other four methodologies to check the robustness of our predicted hedge ratios based on fundamentals.

[17] This approach does not exclude all possible forms of speculation. For example, it doesn't capture the possibility that firms may time the market during a quarter to obtain better delivery prices than the average forward price during the quarter. It is also possible that firms may change their hedge horizon due to changes in their market views, although the average hedge horizon has remained relatively stable throughout the sample period, suggesting that this may not be a serious problem. Finally, as we noted previously, if firms are explicitly speculating on the gold risk premium, and this risk premium is of consistent sign throughout the sample period, it will also create a systematic bias in the predicted hedge ratio.

firms that choose positive hedge ratios. Size, market-to-book ratio, liquidity, and the dividend and credit rating dummies are all significant in explaining the variation of one or more hedge ratios. Descriptive statistics of the predicted hedge ratios are presented in Panel C.

Figure 2 provides time series plots of the median differentials between the actual hedge ratios and the predicted hedge ratios from the Cragg model. These differentials capture the "excess" variation in hedge ratios that cannot be explained by fundamentals. We attribute this excess volatility to selective hedging. For example, if the actual hedge ratio is 80% while the predicted hedge ratio is 50%, then we attribute the "excess" hedge of 30% to selective hedging.

[Place Figure 2 about here]

As in the case of Figure 1, it is evident that the volatility of the hedge ratios attributable to selective hedging is substantial. In fact, 46% of the volatility of 1-year hedge ratios cannot be explained by fundamentals.

We use four alternative methodologies to calculate the predicted hedge ratio benchmarks to check the robustness of our results:

(a) a constant hedge ratio, which equals the time-series average hedge ratio of an individual firm (referred to as "firm average"),

(b) a constant hedge ratio, which equals the industry average hedge ratio over the entire sample period (referred to as "industry average"),

(c) a predicted hedge ratio based on an AR(4) model, and

(d) a predicted hedge ratio based on a MA(4) model.

To obtain the predicted hedge ratios under the AR(4) model we estimate

$$h(t) = a + b * h(t-1) + c * h(t-2) + d * h(t-3) + g * h(t-4) + e$$

on the pooled sample (all firm-years) whenever we observe a positive hedge ratio. Thus, we obtain one regression model (set of parameter estimates) that applies to all firms. Then we calculate predicted values for each firm *i* using

$$predicted\ h(i,t) = a + b * h(i,t-1) + c * h(i,t-2) + d * h(i,t-3) + g * h(i,t-4)$$

As in the Cragg Model estimation, if the actual hedge ratio is zero, then the predicted hedge ratio is set to zero.

With the MA(4) model we calculate the predicted hedge ratios for each firm *i* using

$$predicted\ h(i,t) = \left[h(i,t-1) + h(i,t-2) + h(i,t-3) + h(i,t-4)\right]/4.$$

Under this method the predicted hedge ratio is the moving average of the past four hedge ratio realizations.

We use the predicted hedge ratios calculated using each of these four methods to check the robustness of our analysis based on the hedge ratios predicted from hedging fundamentals. Each of these methods confirms the evidence presented in Figure 2 that there is considerable excess volatility in hedge ratios attributable to selective hedging. It is important to determine whether firms are successful in this form of speculation. In the next section we turn to the analysis of cash flow and value effects associated with the use of derivatives by our sample of firms.

5. Analysis of cash flow and value effects of derivatives use

In this section, we first examine the cash flow impact of firms' derivatives activities. Second, we investigate the origins of the cash flow gains or losses from using derivatives.

Third we analyze the correlations between the use of derivatives and a firm's systematic risk to determine whether derivatives transactions have an effect on shareholder value.

We divide each firm's total derivatives cash flow into two components: (i) the cash flow that a firm would have received had it chosen hedge ratios equal to the predicted hedge ratios throughout the sample period, which we call the *predicted hedge cash flow*, and (ii) the difference between the total derivatives cash flow and the predicted hedge cash flow, which we call the *selective hedge cash flow*.

5.1 Total derivatives cash flows

As noted in Section 2, if a firm is unsuccessful at selective hedging and if average realized risk premia are zero, then the average total derivatives cash flow over the sample period should be zero. A non-zero figure would either indicate the realization of persistent non-zero risk premia, or that firms are able to profit from selective hedging, or both. Table 3 reports descriptive statistics of the total cash flow associated with derivatives usage.

[Place Table 3 about here]

During the 1989-1999 study period those gold mining firms that hedged their future gold production earned an average positive cash flow of $2.73 million per quarter. These gains are substantial given that their average quarterly net profit was only $0.87 million. The aggregate hedging benefit across all firms in our sample exceeded $3.9 billion. On a per ounce basis, firms that hedged gained on average $6.35 per quarter ($25 per year) per ounce of gold hedged, and $3.36 per quarter ($14 per year) per ounce of expected gold production. These numbers are economically significant given the slim profit margins in the gold mining industry during the sample period.

In Panel B of Table 3, we report total derivatives cash flows separately for two sub-periods in our sample when gold prices were falling and a third sub-period when they were rising. Total derivatives cash flows were significantly positive in all three sub-periods. However, they were substantially higher when prices were falling, indicating (not surprisingly) that realized risk premia were significantly higher when realized spot prices were declining.[18]

There appears to be substantial variation in firms' total derivatives cash flows. The standard deviation of the total quarterly cash flows is $18.75 million or $18 per ounce of gold hedged. The high variation is also apparent from the distribution of total derivatives cash flows across firms, plotted in Figure 3.

[Place Figure 3 about here]

Figure 4 plots the total derivatives cash flows (industry mean and median) over time. The graph shows that firms generated significant positive cash flows from their derivatives activities, except for a relatively brief period from mid 1993 to mid 1995, when cash flows fluctuate around zero. This period coincided with the period when gold prices were generally rising. This came as a surprise to us. We had expected to find substantial losses for hedgers during times of rising gold prices.

[Place Figure 4 about here]

Finally, we have also examined the average total derivatives cash flow for each firm separately. Out of a total of 92 firms only 7 produced negative average total derivatives cash flow. These results show that hedging has been tremendously profitable for most gold mining

[18] Our regression results presented in Section 5.2 (Table 6) confirm the presence of a persistently positive gold risk premium even after controlling for changes in gold prices.

firms during the sample period. We investigate the possible origins of these hedging gains in the next subsection.

5.2 Selective hedge cash flows and risk premia

The analysis in Section 4 revealed that firms frequently adjust the size of their derivatives positions (as measured by changes in the hedge ratio). Such adjustments could be a result of a firm changing its market views with respect to future spot prices. The volatility of hedge ratios seems too high to be caused solely by changing firm fundamentals.

To determine whether a firm was able to earn abnormal returns by speculating on its market views, we analyze the selective hedge cash flow, i.e., the difference between a firm's total derivatives cash flow and its predicted hedge cash flow. We also analyze the predicted hedge cash flow for evidence of risk premia. To calculate the predicted hedge cash flow we use a firm's actual derivatives portfolio, except that we recalculate the number of contracts outstanding for each instrument using

$$N_{predicted} = N_{actual} \times \frac{\text{predicted hedge ratio}}{\text{actual hedge ratio}},$$

where N_{actual} equals the number of contracts outstanding for each contract type. The predicted hedge ratio is estimated from the Cragg model or one of the four alternative benchmarks discussed in the previous section, and $N_{predicted}$ is the corresponding number of contracts. We calculate the predicted hedge cash flow using exactly the same procedure as the one we used for the calculation of total derivatives cash flow, described in Appendix C.

Table 4 reports summary statistics of the predicted hedge ratio cash flows (Panel A), and the respective selective hedge cash flows (Panel B) using all five methodologies.

Regardless of which methodology we use, the predicted hedge ratio cash flows are positive and highly significant (at the one-percent level), similar to the firms' total derivatives cash flows reported in Table 3. The selective hedge cash flows, measured on a $/ounce of gold hedged basis, are generally zero, except when we use the predicted hedge ratios from the Cragg model and when we compute the predicted hedge ratios from the MA(4) model (median only). However, in all cases the selective hedge cash flows are economically small compared to the corresponding predicted hedge ratio cash flows.

[Place Table 4 about here]

To check the robustness of our results further, we repeat the previous analysis for the three sub-periods. Gold prices were generally falling during the first and third sub-periods and rising during the middle sub-period. The results are reported in Table 5. Using all five methodologies, firms' predicted hedge ratio cash flows were significantly positive at the 1% level when prices were falling. When prices were rising, the predicted hedge ratio cash flows were significantly positive only under the AR(4) model. As noted previously, it is surprising that firms don't make significant losses when gold prices are rising. The selective hedge cash flows are again close to zero, although some of the values are statistically significant at the 5% level. We find positive selective hedge cash flows only when gold prices were falling.[19]

[Place Table 5 about here]

Thus, the overall evidence for the cash flows associated with each of the five predicted hedge ratio benchmarks is consistent with our previous findings of significantly positive total

[19] The difference in selective hedge cash flow gains between down markets and up markets could be partly attributed to the fact that it is easier for firms to speculate on gold price decreases than on gold price increases without taking explicitly speculative positions. A significant fraction of our sample firms have zero hedge ratios most of the time. Firms (especially those who have low hedge ratios to begin with) can speculate on expected price declines by simply increasing their hedge ratios, whereas they would need to reverse the direction of the derivatives position (i.e. long gold) to fully exploit an expected price increase.

derivatives cash flows. It is especially surprising that firms that hedge do not incur large losses during periods of rising prices. The evidence in support of significantly positive selective hedge cash flows is considerably weaker, both statistically and economically. However, even the few observations of significantly positive selective hedge cash flows is inherently interesting since we would not expect firms to be able to consistently outperform the market by timing it.[20]

The large positive returns from maintaining a predicted or constant hedge ratio are consistent with the presence of risk premia in the gold forward market. In particular, if forward prices consistently exceed future realized spot prices (indicating positive risk premia), then short positions in the gold market would yield positive returns on average. This is indeed the case over our sample period. Panel A of Table 6 reports the risk premia, expressed in both dollar and percentage return terms, for the five different contract maturities over a 24-year period, from 1979 to 2003. All risk premia are significantly positive. For example, if a speculator had shorted one-year forwards every month between 1979 and 2003, and had held each contract until maturity, then the speculator would have earned $25 per ounce of gold per year on average. Using two-year contracts a speculator could have earned $36 per ounce per year on average going up to $45 per ounce per year for five-year contracts. On average, forward prices exceeded future spot prices by about 6% p.a. The average realized cash flow by the mining firms of $6.35 per ounce hedged per quarter ($25 per ounce per year) is consistent with the average one-year risk premium.

[Place Table 6 about here]

[20] We have repeated all our cash flow calculations after excluding options to control for the possibility of a bias in our hedge ratio estimates, as discussed in Section 4 (footnote 13). Our results remain unchanged. However, this could be either because the bias is insignificant or because options positions make up a relatively small proportion of total derivatives positions.

We analyze the determinants of the observed risk premia in Panels B and C of Table 6. In Panel B, we regress the one-year realized risk premium on the three Fama-French factors, and the gold return.[21] All variables are measured over the same holding period. Since we use monthly data in the estimation, the overlapping time-series observations cause serial correlation in the error terms. We use the Hansen and Hodrick (1980) procedure to correct for the serial correlation. In each of the three regression models, the intercept term and the gold return coefficient are highly significant. The positive intercept confirms our finding of a persistent positive risk premium of about 6% p.a. Neither the market return nor the other two Fama-French factors are significant, indicating that there is no systematic risk component in the realized gold risk premium. In Panel C, we repeat the risk premium analysis, but this time follow the approach of Bessembinder (1992). Instead of calculating the returns from holding futures contracts until maturity, we now calculate the monthly returns of short futures positions. The results are consistent with our findings in Panel B.

Figure 5a plots the realized risk premia in the gold market for the period 1979-2003. The realized risk premia calculated using 3, 4, and 5-year futures contracts are always positive except at the very beginning of the period when the gold price increased dramatically. Risk premia calculated using 1- and 2-year futures contracts are mostly positive throughout this 24-year period. Indeed, during the 1989-1999 period of our derivatives sample, only the 1- and 2-year contracts entered into in 1992 and 1993 would have turned out to be unprofitable. Figure 5b plots the distributions of risk premia during the 1979-2003 period for each of the five contracts in our study. The likelihood of a positive value increases with the maturity of the forward contract, but in each case the means are clearly positive.

[21] The one-year risk premium is calculated as the return of holding 1-year futures contracts until maturity. We repeated the analysis using the holding-period returns of 2, 3, 4, and 5-year futures contracts, and obtained very similar results.

[Place Figures 5a & 5b about here]

Thus, gold producers that sold gold in the forward market could have benefited handsomely from a persistent positive risk premium. The situation here is somewhat analogous to the case of Metallgesellschaft (MG) that we discussed in Section 2. While MG could have hedged its long term fuel sales contracts by accumulating a physical fuel reserve in the spot market, it instead chose to hedge through "synthetic storage," i.e. entering into long futures contracts, to benefit from the persistent negative basis in oil futures.[22] The difference between MG and gold producers is that while the basis, i.e. the difference between the futures price and the current spot price, is observable at the time the futures position is entered into, the risk premium is not. Therefore, while a buyer of oil futures can lock in a price advantage in the basis, a seller of gold futures will face uncertainty about the realized value of the risk premium.[23] Nonetheless, a gold producer has an inherent advantage over a gold trader in implementing a derivatives strategy designed to exploit an expected forward-spot differential. A gold trader would need to buy gold in the spot market and store it in order to back a forward gold sales program. If the realized risk premium turns out to be negative, it is possible for the trader to incur losses that are large enough to cause financial distress. In contrast, a gold producer who sells gold forward and realizes a negative risk premium will only incur the opportunity cost of not being able to sell the gold at a realized spot price that is higher than the contracted forward price. Additionally, a gold producer is likely to be able to store gold at a significantly lower cost than a trader.

[22] See Culp and Miller (1995) for a discussion of the economics of MG's synthetic storage program.
[23] While MG also ended up being exposed to the risk of a reversal in the basis, this was due to the mismatch in maturities arising from their "stack and roll" strategy.

5.3 Derivatives cash flow and shareholder value

Positive cash flows realized by a firm from the use of derivatives do not necessarily translate into an increase in shareholder value. As we have discussed previously, positive risk premia in forward prices could arise when the underlying asset has systematic risk. If the firm increases its systematic risk by selling gold forward, its shareholders should increase their required rate of return from holding the firm's stock. Thus it is possible that the positive derivatives cash flows that we have detected are offset by an increase in the firm's discount rate, resulting in no net increase in shareholder value. In this section we therefore examine the impact of hedging on a firm's systematic risk for our sample of gold mining firms.

We first estimate the basic market model for each of the firms in our sample,

$$R_i = \alpha + \beta R_m + \varepsilon ,$$

where R_i, R_m are the returns on the firm's stock and the market, respectively.[24] We use the CRSP NYSE/AMEX/Nasdaq composite value-weighted index as the market portfolio for companies listed in the U.S. and the CFMRC value-weighted index for companies listed only in Canada. Next we regress the estimated annual stock market betas on firms' hedge ratios and control variables reflecting size, leverage and diversification, for the sub-sample of firms that hedge. Firm size equals the book value of assets, leverage is defined as the ratio of long-term debt plus preferred stock over long-term debt plus preferred stock plus common equity, and the two diversification variables represent Herfindahl indices based on the value of assets in different business segments, and the value of production of different metals. If the hedging of gold price risk causes shareholders to increase their required return from holding the firm's

[24] As in Tufano (1998), we have also estimated a market model that includes the return on gold, i.e. $R_i = \alpha + \beta R_m + \gamma R_{Gold} + \varepsilon$, but found no significant effect on our beta estimates. We have also used weekly data instead of daily data, but again found no significant impact on the beta estimates.

stock then we would expect a positive correlation between firms' beta estimates and the extent to which they hedge. The results are reported in Table 7, both with and without firm fixed effects.

[Place Table 7 about here]

As the results in Table 7 reveal (Panels A1 and A2), there is no evidence that hedging increases stock market betas for our sample of firms. The results are robust to adding the control variables, as shown in Panels B1 and B2. In the regressions with firm fixed effects, leverage is the only control variable that is statistically significant, possibly because it is the only control variable that varies cyclically over our 10-year sample period. When we remove the fixed effects, asset diversification is the only control variable that is (strongly) significant, with market beta increasing as asset diversification increases (i.e. the Herfindahl index decreases). As Tufano (1998) has pointed out, market betas of gold mining firms are very low (only 11.4% of market betas in his sample are statistically different from zero), and our finding suggests that when firms increase their activities outside the gold industry, they are likely to move into industries that have higher systematic risk. Our overall finding that market beta is not increased by hedging is surprising since it suggests that the cash flow gains from hedging translate into value gains for shareholders.[25]

D. Selective hedge cash flows across firms

We now return to examining the gains from selective hedging. The results in Table 5 show that the gains from selective hedging are, on average, small at best. However, the standard deviation of the selective hedge cash flows is quite large. There are a significant

[25] For US companies we have also specified a Fama-French three factor model, and examined the impact of hedging on all three factors. No statistically significant relation between any of the three factor sensitivities and the extent of hedging was found.

number of quarterly observations that reveal gains from selective hedging, but an equal number that reveal losses. About 50% of firms gain or lose more that $5/oz per quarter per hedge contract. Figure 6 shows that the distribution of the selective hedge cash flows (using the Cragg Model predicted hedge ratio benchmark) is symmetric and centered near zero.[26]

[Place Figure 6 about here]

In Figure 7, we plot the industry mean and median selective hedge cash flows (using both the Cragg Model and the firm average predicted hedge ratio benchmarks) over time. Non-parametric tests reveal that neither times-series can be distinguished from a random draw.[27] This implies that the industry as a whole is not gaining from selective hedging.

[Place Figure 7 about here]

It is interesting to note that the volatilities of the mean and median selective hedge cash flows are time dependent. From 1994 to 1997, the volatilities appear to be significantly lower than during the rest of the sample period. Interestingly, total derivatives cash flows were at their lowest level during the same 1994 to 1997 period. While this could be a pure coincidence, it is also possible that firms are more willing to speculate when derivatives portfolios generate a lot of extra cash than when derivatives portfolios generate little or no extra cash.

Next we investigate the determinants of selective hedge cash flows, and whether there are systematic differences between winners and losers. For example, are firms' selective hedge cash flows related to their level of hedging (hedge ratio), or how frequently they adjust their hedge ratios (hedge ratio volatility)? As noted in footnote 19, firms that typically hedge either 100% of their output or nothing at all have less flexibility to hedge selectively than

[26] We obtain a similar pattern when we use the fixed hedge ratio as a benchmark.
[27] We use the one-sample runs test of randomness described in Siegel and Castellan (1988).

firms that typically hedge about 50% of output. Therefore it is possible that any relationship between selective hedge cash flows and hedge ratios could be non-linear. Panel A of Table 8 reports the results of OLS regressions between selective hedge cash flows and firms' hedge ratios, the square of hedge ratios, and the hedge ratio volatilities. Since derivatives cash flow increases monotonically with the risk premium, we use the one-year realized risk premium as a control variable. While the risk premium is highly significant as expected, none of the other variables (except hedge volatility of four-year hedges (x = 4)) has any statistical significance. Thus, selective hedge cash flows do not seem to be related systematically to how much firms hedge or the frequency with which they adjust their hedge ratios.

[Place Table 8 about here]

As argued in Section 2.2, firms that hedge selectively will increase their hedge ratios when they expect the risk premium to increase and *vice versa*. If they are successful in predicting the direction of the hedge ratio and change their hedge ratios accordingly, we would expect to find a positive correlation between the selective hedging component of the hedge ratio and the realized risk premium. We investigate this question by regressing the time t residuals from the Cragg Model estimations in Table 2 on the realized gold return between t and t+1. The results are reported in Panel B of Table 8. None of the models have any explanatory power, indicating the lack of any significant relation between the selective component of the hedge ratio and the realized risk premium.

Even though we find that gold mining firms as a group do not outperform the market, it could be that there are persistent winners and losers. We therefore investigate whether obtaining a positive (negative) selective hedge cash flow in one quarter increases the likelihood that a firm will generate a positive (negative) selective hedge cash flow in the next quarter. Table 9 shows the probabilities of generating a positive and negative selective hedge cash flow for each quarter, given that the selective hedge cash flow in the previous quarter was either positive or negative. Binomial tests are used to determine whether any probability differs statistically from ½. The results show that most probabilities are statistically not different from ½, implying that there is no persistence. If probabilities are statistically significant they indicate reversal rather than persistence: A positive selective hedge cash flow in one quarter increases the likelihood that a firm will experience a negative selective hedge cash flow in the following quarter, and vice versa. Thus, we find no persistent winners or losers in selective hedging.

[Place Table 9 about here]

In summary, we have found no convincing evidence that firms consistently outperform the market by hedging selectively. On the one hand, we reveal weak evidence of significantly positive average selective hedge cash flows across firms. On the other hand, while there are winners and losers at each point in time, there are no significant cross-sectional differences between winners and losers, and there are no persistent winners and losers. These results indicate that although the gold mining firms in our sample seem to speculate by changing their hedge ratios over time, this does not translate into economically significant derivatives cash flows that we could attribute to successful market timing.

6. Conclusions

We study corporate speculation within the confines of hedging programs, and make several contributions to the risk management literature. We examine the basic premise in the literature that derivatives transactions have zero intrinsic net worth, and find that this assumption can be violated over an extended time period. We link the cash flow and value gains from using derivatives to risk premia in derivatives markets, and argue that these risk premia can be a potentially important motive for the corporate use of derivatives. In contrast, despite considerable evidence that firms try to time the market when they use derivatives, we show that the expected benefits from selective hedging are small at best. Our analysis also provides new insights for future empirical studies on measuring the benefits of derivatives use.

There is no *ex ante* reason to believe that the market and corporate behaviors we identify in this paper are unique to the gold market, especially in view of the large body of literature that shows the presence of risk premia in a wide range of currency and commodity markets. To our knowledge, there has been no previous systematic attempt to study the impact of risk premia or derivatives market imperfections on corporate risk management. Thus, our study helps to provide focus on a new and potentially fruitful area of research.

Appendix A
Companies in the Sample

AGNICO EAGLE MINES LTD
ALTA GOLD COMPANY
AMAX GOLD INC
ANVIL RANGE MINING
ASAMERA MINERALS INC
ATLAS CORP
AUR RESOURCES INC
ARIEL RESOURCES
AURIZON MINES
BARRICK GOLD CORPORATION
BATTLE MTN GOLD CO
BEMA GOLD CORP
BLACK HAWK MINING INC
BOLIDEN LTD
BOND INTL GOLD
BREAKWATER RESOURCES LTD
CAMBIOR INC
CAMPBELL RESOURCES INC
CANYON RESOURCES CORP
CLAUDE RESOURCES INC
COEUR D'ALENE MINES CORP
COMINCO LTD
CROWN RESOURCES CORP
CATHEDRAL GOLD
DAKOTA MINING CORP
DAYTON MINING CORP
DICKENSON MINES LTD
ECHO BAY MINES LTD
ELDORADO GOLD CORP
EQUINOX RESOURCES LTD
EURO-NEVADA MINING LTD
EDEN ROC
FRANCO-NEVADA MINING CORP
FREEPRT MCMOR COPPER & GOLD
GALACTIC RESOURCES LTD
GEOMAQUE EXPLORATIONS LTD
GETCHELL GOLD CORP
GIANT YELLOWKNIFE MINES LTD
GLAMIS GOLD LTD
GOLDCORP INC
GOLDEN KNIGHT RESOURCES INC
GREENSTONE RES LTD
HECLA MINING CO
HEMLO GOLD MINES INC
HIGH RIVER GOLD MINES LTD
HOMESTAKE MINING
HYCROFT RESOURCES
INMET MINING CORP
INTERNATIONAL CORONA
KINROSS GOLD CORP
LAC MINERALS LTD
MERIDIAN GOLD INC
MIRAMAR MINING CORP
MK GOLD COMPANY
MONARCH RESOURCES
NEWMONT GOLD COMPANY
NEWMONT MINING CORP
NORTHGATE EXPLORATION LTD
NORTHWEST GOLD CORP
PEGASUS GOLD INC
PIONEER GROUP INC
PLACER DOME INC
PRIME RESOURCES GROUP INC
RAYROCK YELLOWKNF RESOURCES
REAL DEL MONTE MINING CP
REPUBLIC GOLDFIELDS
RICHMONT MINES INC
RIVER GOLD MINES
ROYAL OAK MINES INC
SANTA FE PACIFIC GOLD CORP
SONORA DIAMOND CP LTD
TECK CORP
TVX GOLD INC
U S GOLD CORP
USMX INC
VICEROY RESOURCE CORPORATION
VISTA GOLD CORP
WHARF RESOURCES LTD
WHEATON RIVER MINERALS LTD
WILLIAM RESOURCES INC
WESTMIN

Appendix B. Example of the Raw Data

The table below shows the total gold derivatives positions of Placer Dome as of December 31, 1998. The maturity year of all contracts is given in the top of each panel. The first column in each panel lists the number of ounces of gold that must be delivered under the various contracts. The second column lists the respective delivery prices, and the third column records the percentage of future gold production that has been hedged. SDC stands for spot-deferred contracts. A spot-deferred contract is like a forward contract except that delivery can be deferred for several years at the discretion of the deliverer. If delivery is deferred, the new delivery price is set to equal the prior contract price plus the current contango premium.

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

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

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

Appendix C. Calculation of quarterly cash flows attributable to derivatives transactions

The data set contains quarterly observations on all outstanding gold derivatives positions, their size and direction, the instrument types, maturities, and the respective delivery prices for each instrument. Firms' derivatives portfolios consist of short positions in linear instruments (forwards, spot-deferred contracts and gold loans), long positions in put options, and short positions in call options.[28] We infer the cash flows that are a result of changes in the quarterly derivatives positions from these quarterly observations on derivatives positions together with market data, e.g. average interest rates, and forward and spot prices.

C.1 Calculation of cash flows from linear contracts

We treat the cash flows from all linear contracts (forwards, spot-deferred contracts, and gold loans) identically. Let N denote the number of linear contracts outstanding, and c the net change of the position between t-1 and t. Then the number of contracts outstanding at t-1 and t are related by the following equation:

$$N_t = N_{t-1} + c_t .$$

If c is positive, the firm increased its derivatives position and if c is negative, it decreased its derivatives position. If $c_t \neq 0$, then the reported delivery prices X_t and X_{t-1} are related by the following equation:

$$X_t = \frac{N_{t-1} X_{t-1} + c_t X_t^i}{N_t},$$

[28] We ignore contingent forwards, variable forwards, short positions in puts, and long positions in calls. A few firms started using these less conventional strategies in 1999, the last year in our sample, but the positions were negligible.

where X^i denotes the inferred delivery price that corresponds to the net change c. Solving for X^i yields

$$X_t^i = \frac{N_t X_t - N_{t-1} X_{t-1}}{c_t}.$$

We assume that linear positions are closed out at the average forward price during a quarter. The resulting cash flow from a short (linear) position is therefore given by

$$Linear\,CF_t = -c_t (X_t^i - \overline{F}_t) \times e^{-rT},$$

where F_t denotes the average forward price between t-1 and t, and T is the remaining maturity of the contract (T > 3 months).[29] If the remaining maturity of a linear contract is less than three months, then we assume that the contract is closed out at the average spot price during the quarter. Thus,

$$Linear\,CF_t = -c_t (X_t^i - \overline{S}_t).$$

If $c_t = 0$, then there is no net change in the position. However, occasionally firms report changes in delivery prices. This can happen if the firm renegotiated the terms of a derivatives position with the counterparty. In this case the cash flow is calculated as follows.

$$Linear\,CF_t = N_t (X_{t-1} - X_t) \times e^{-rT}$$

C.2 Calculation of cash flows from option positions

Option positions consist of put options (long) and call options (short). We assume that all option contracts are European options and value them according to the Black-Scholes formula. To calculate the quarterly cash flow from a firm's option positions we assume that the entire

[29] It is easy to show that our methodology for calculating cash flows from linear positions is equivalent to assuming that all linear positions at *t-1* are closed out at the average forward price during the following quarter, and that all linear positions at *t* are entered into when the forward price equaled the average forward price during the previous quarter. We use the latter approach for calculating options cash flows in *C.2*.

option position at t-1 is closed out in the middle of the following quarter and that the entire option position at t is entered into at the same time. Thus, both transactions are assumed to take place at identical market conditions.[30] The cash flow from a firm's put options positions, which mature in more than three months, is given by

$$Put\,CF_t = \text{CF from liquidating options position} - \text{CF from buying new options position}$$

$$Put\,CF_t = N_{t-1} \times f(Y_{t-1}, T_{t-1} - 1.5; \overline{S}_t, \overline{r}_t, \overline{\sigma}_t, \overline{y}_t) - N_t \times f(Y_t, T_t + 1.5; \overline{S}_t, \overline{r}_t, \overline{\sigma}_t, \overline{y}_t)$$

where $f(.)$ denotes the Black and Scholes option pricing formula, N the number of options, Y the respective strike prices, T is the maturity of the contract, and r, σ, and y denote the average risk-free rate, the average volatility of the underlying asset, and the average net-convenience yield respectively between t-1 and t. Options positions which mature in less than three months are assumed to be exercised if they expire in-the-money during the following quarter. Their cash flow is given by

$$Put\,CF_t = N_{t-1} \times \max(0, Y_{t-1} - \overline{S}_t)$$

The corresponding cash flows from call positions are

$$Call\,CF_t = -\left(N_{t-1} \times f(Y_{t-1}, T_{t-1} - 1.5; \overline{S}_t, \overline{r}_t, \overline{\sigma}_t, \overline{y}_t) - N_t \times f(Y_t, T_t + 1.5; \overline{S}_t, \overline{r}_t, \overline{\sigma}_t, \overline{y}_t)\right)$$

$$Call\,CF_t = -N_{t-1} \times \max(0, \overline{S}_t - Y_{t-1})\,.$$

The aggregate derivatives cash flow (*TotalCF*) is given by the summation of the cash flows of all outstanding positions.

$$TotalCF_t = \sum Linear\,CF_t + \sum Option\,CF_t$$

[30] This assumption is necessary in order to infer cash flows rather than profits from a change in a firm's options positions.

C.3 Total cash flow of hedging portfolio per ounce of gold hedged

The total number of ounces of gold hedged (*NT*) equals the number of ounces deliverable under forwards, spot-deferred contracts, gold loan positions, and put options. We also add the number of call option positions *in excess* of put option positions to the number of ounces hedged.[31]

$$NT = N(\text{forward}) + N(\text{spot deferred}) + N(\text{loan}) + \max\{N(\text{put}), N(\text{call})\}$$

To determine the total cash flow of a hedging portfolio per ounce of gold hedged, we divide the total derivatives cash flow at time t by the number of hedging contracts. Unfortunately, it is not clear whether NT_t or NT_{t-1} is the appropriate denominator. The problem is that cash flows may be generated when a firm enters into a new position as well as when it closes out an existing position. In the first case, NT_t would be the correct denominator while in the latter case NT_{t-1} would be the correct denominator. We therefore use $\max\{NT_t, NT_{t-1}\}$ as the denominator, and calculate the total derivatives cash flow per ounce of gold hedged as follows.

$$TotalCFNT_t = \frac{TotalCF_t}{\max\{NT_t, NT_{t-1}\}}$$

C.4 Construction of market data

We calculate the average gold spot price, the average (historical) gold price volatility, and the average interest rates from daily data. We calculate the average gold lease rate from monthly data. Missing risk-free rates are interpolated linearly using two adjacent data points. Due to

[31] This is done in order to avoid double counting. A forward contract can be replicated by a put and a call. If the firm chose to hedge with options rather than with a forward contract, and the number of puts and calls are both counted, then the firm's hedge position would appear twice as large compared to a firm that hedged with forwards.

missing data, the term structure of gold lease rates is assumed to be flat. Interest rates, the gold lease rate, and the gold price volatility are calculated as monthly rates assuming continuous compounding. We use two methods to infer forward gold prices. First we calculate them using the equation:

$$F_t = S_t \times e^{(r-y)T}$$

where y is the gold lease rate and r is the risk-free rate. Second, we use actual futures prices to approximate current forward prices. Since 1990, futures contracts with maturities ranging from 1-5 years are generally available. If the futures price for a particular maturity is missing we interpolate linearly between two adjacent futures prices. If possible we interpolate between two futures prices, but occasionally extrapolate out-of-range, e.g., derive a 5-year futures price from 3-year and 4-year futures prices. It appears that the relationship between futures prices of different maturities is almost perfectly linear. Furthermore, we verify that the interpolated futures prices are very close to the forward prices calculated using the above formula.

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Figure 1

Median Hedge Ratios in the Gold Mining Industry: 1989-1999

Derivatives Users Only

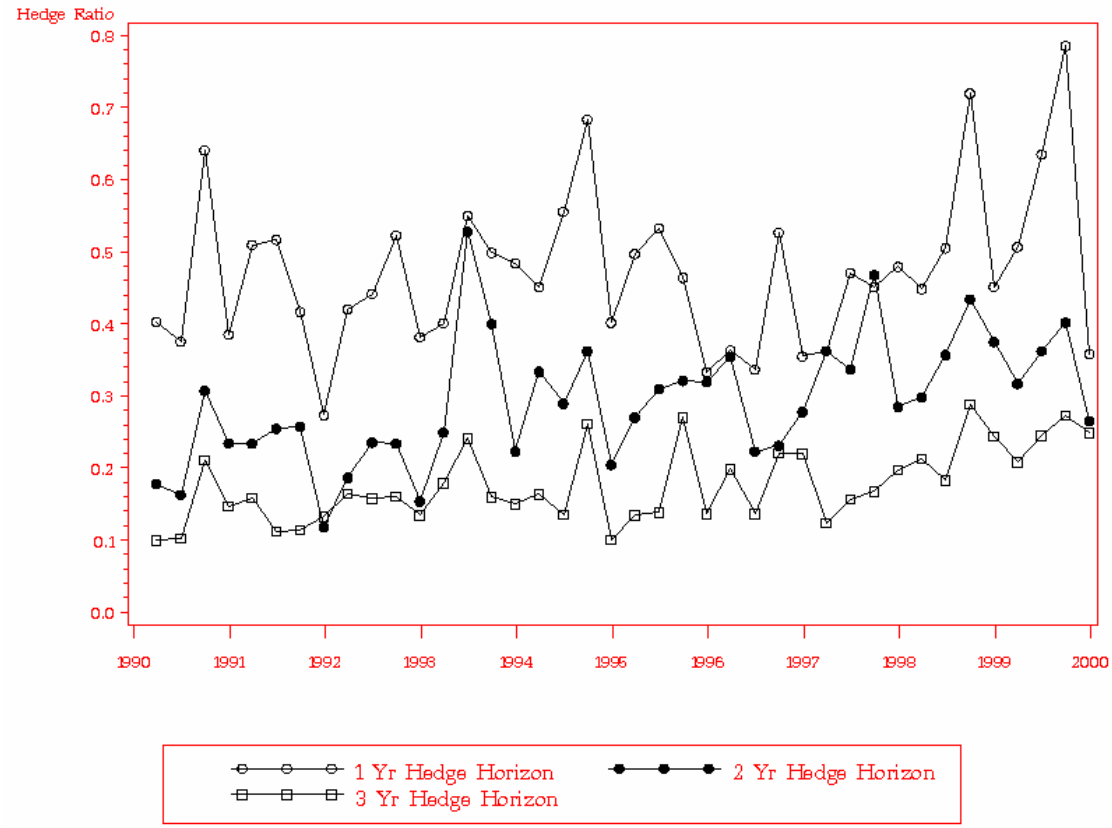


Figure 2

Median Differentials between Actual and Predicted (Cragg Model) Hedge Ratios: 1989-1999

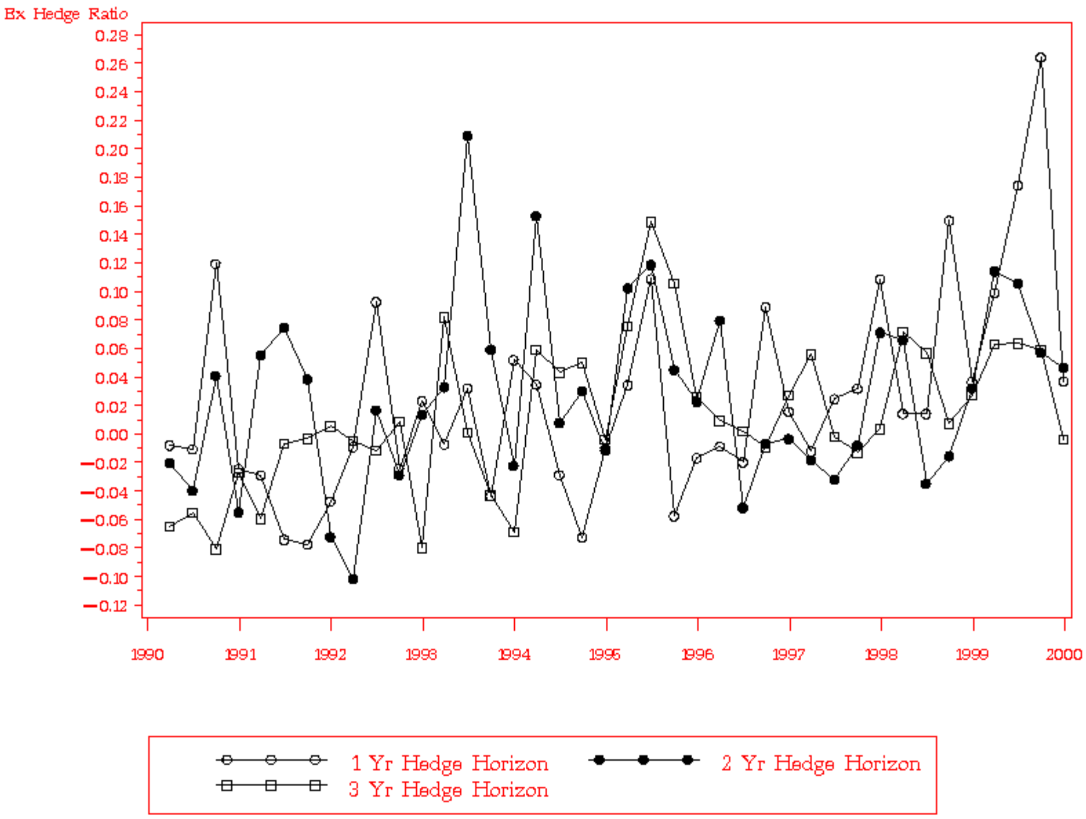


Figure 3

Distribution of Total Derivatives Cash Flows
(in US$ per ounce of gold hedged)

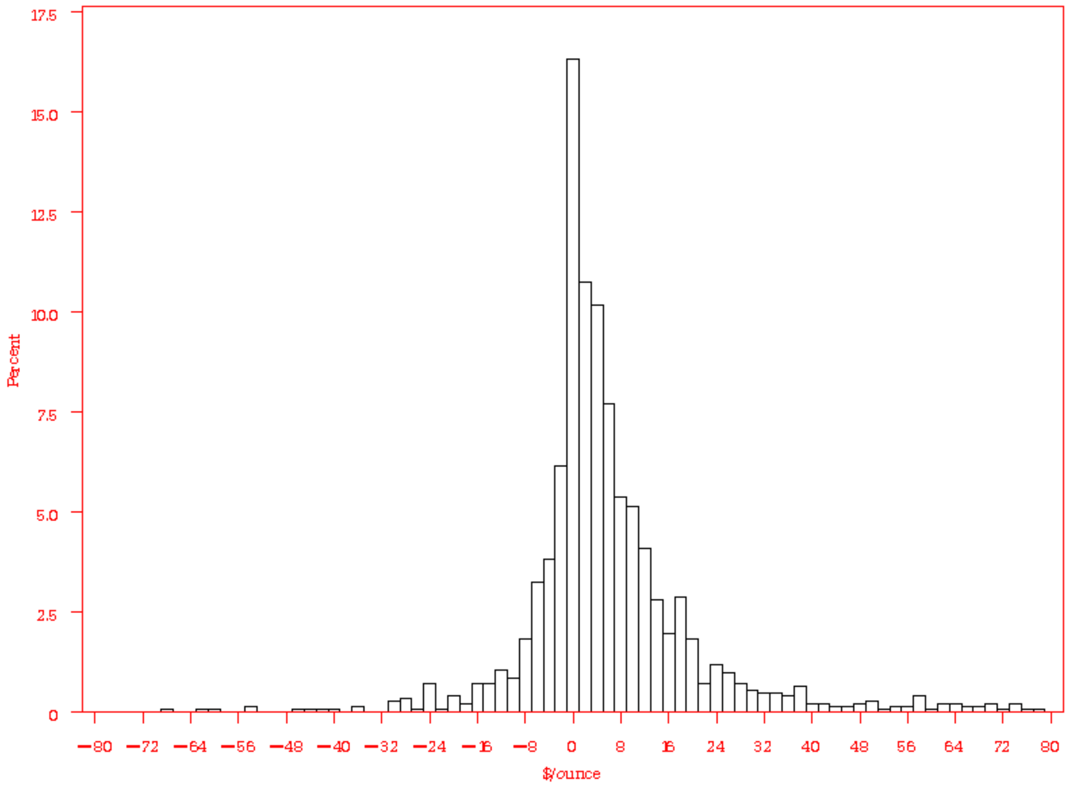


Figure 4

Total Derivatives Cash Flows: 1989-1999
(in US$ per ounce of gold hedged)

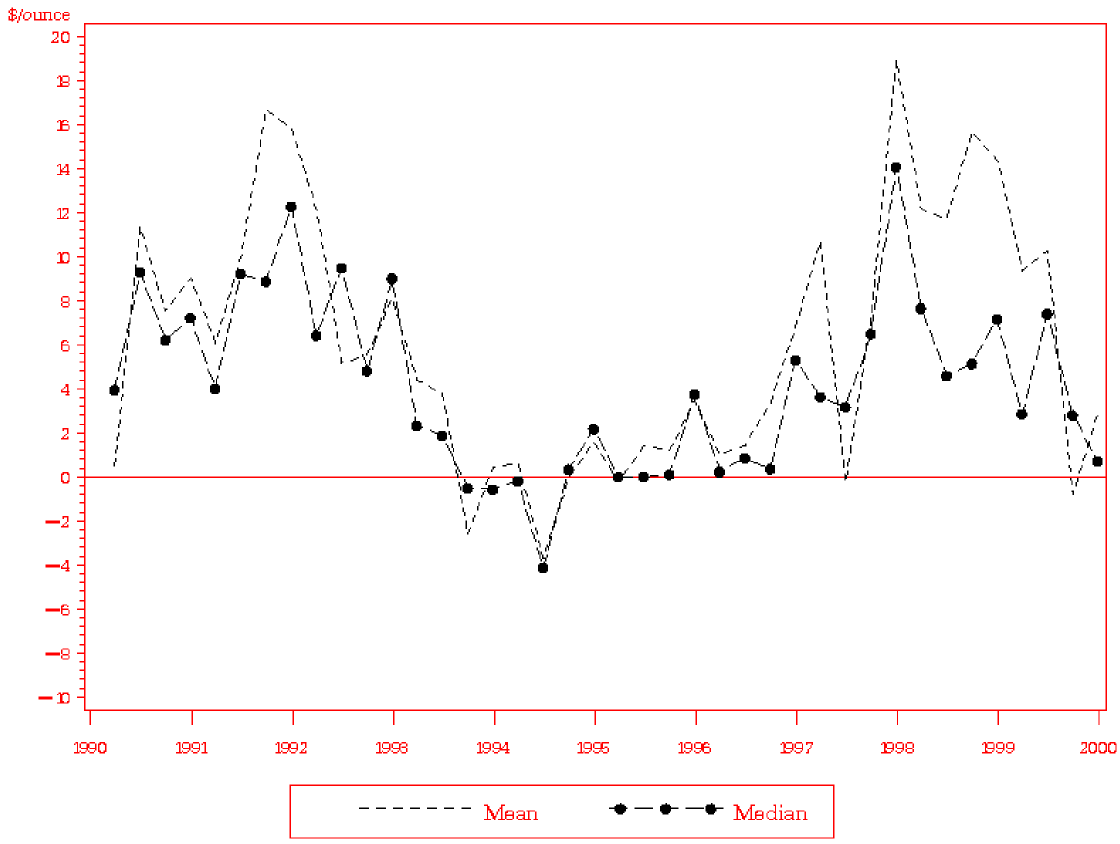


Figure 5a

Realized Risk Premia in the Gold Market: 1979-2003

[1 + (F(t,T) – S(T))/F(t,T)]^(1/(T-t))-1, for (T-t) = 1,2,3,4,5 years

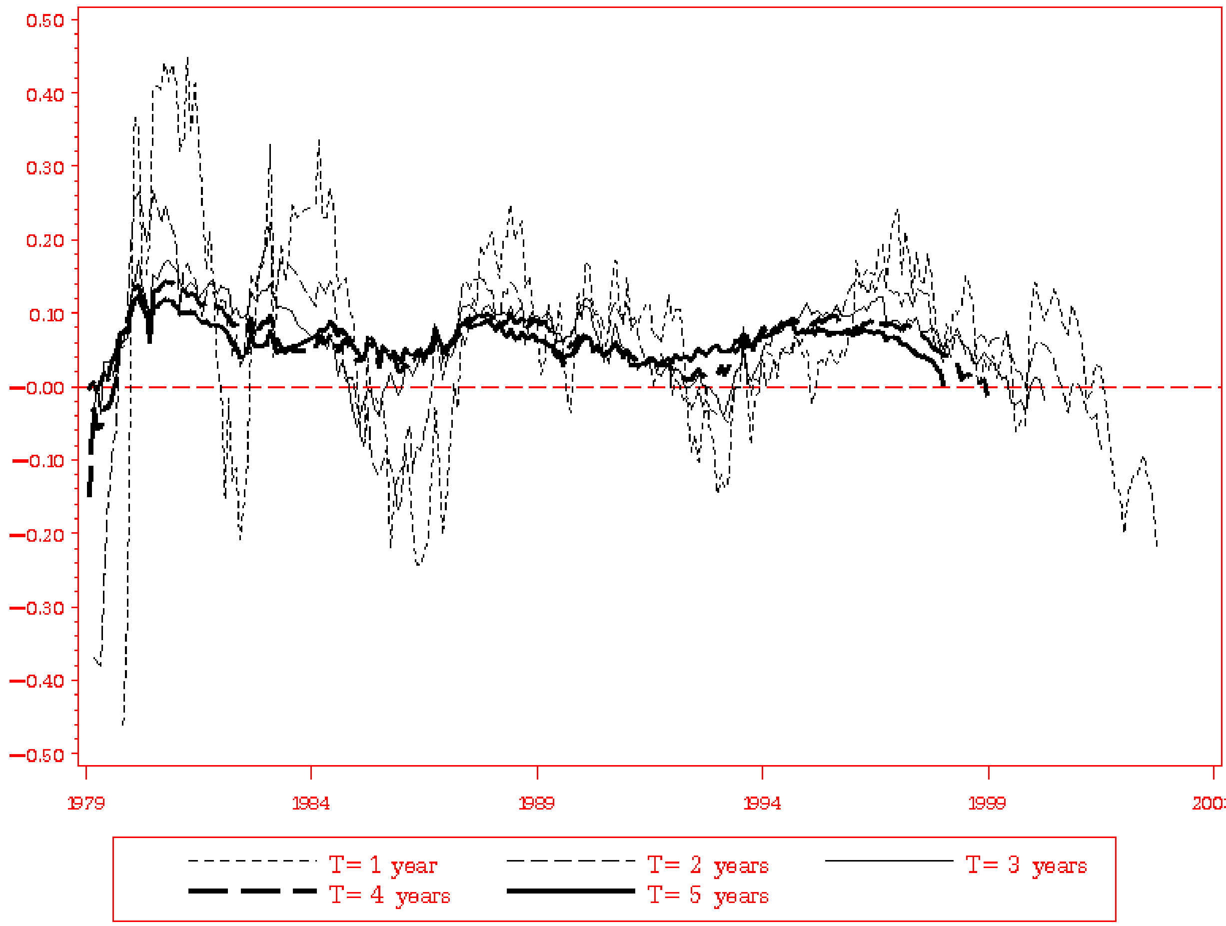


Figure 5b

Distributions of Realized Risk Premia in the Gold Market: 1979-2003

[1 + (F(t,T) – S(T))/F(t,T)]^(1/(T-t)) -1, for (T-t) = 1,2,3,4,5 years

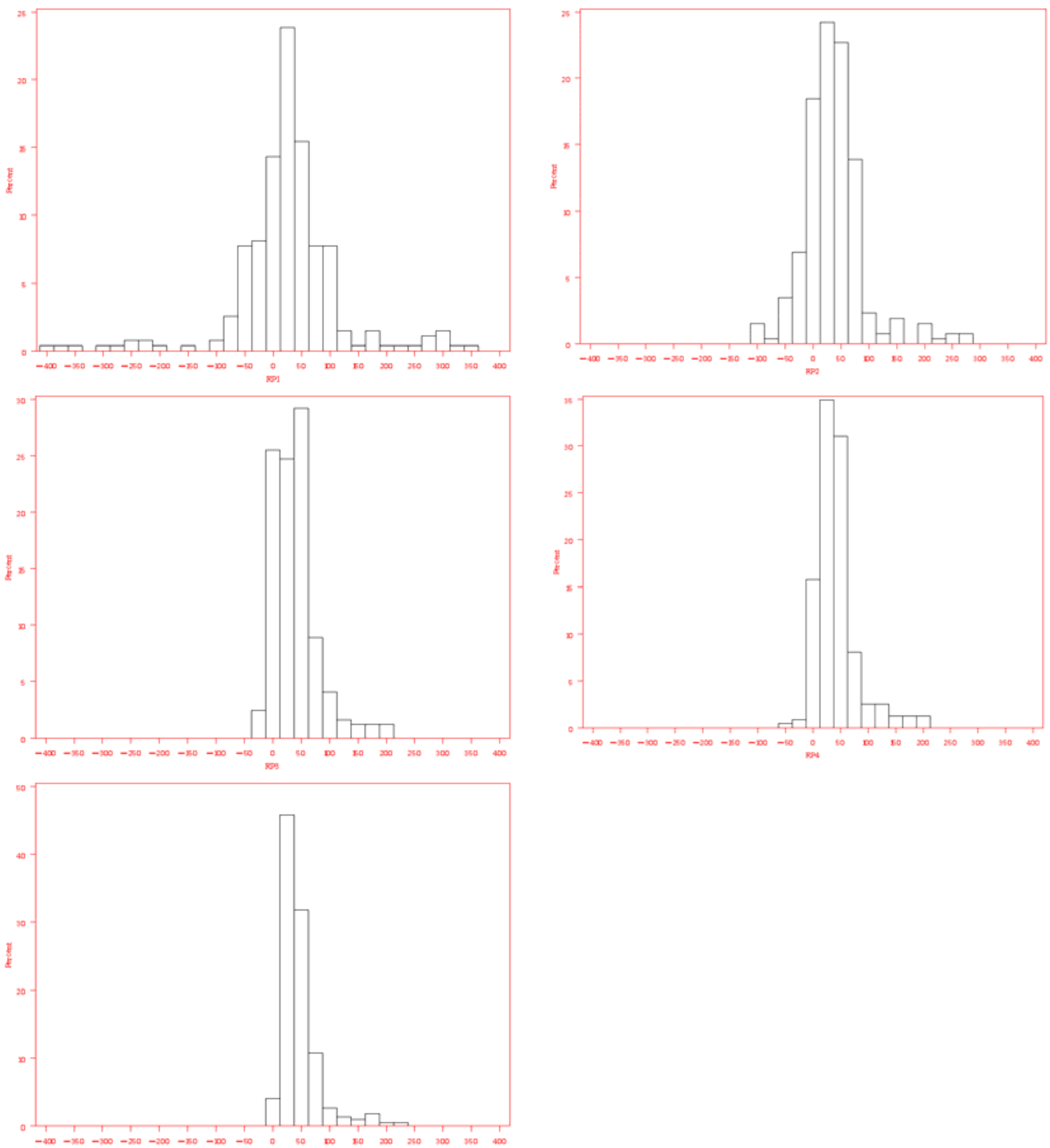


Figure 6

Distribution of Selective Hedge Cash Flows based on Cragg Model Predicted Hedge Ratio Benchmark (in US$ per ounce of gold hedged)

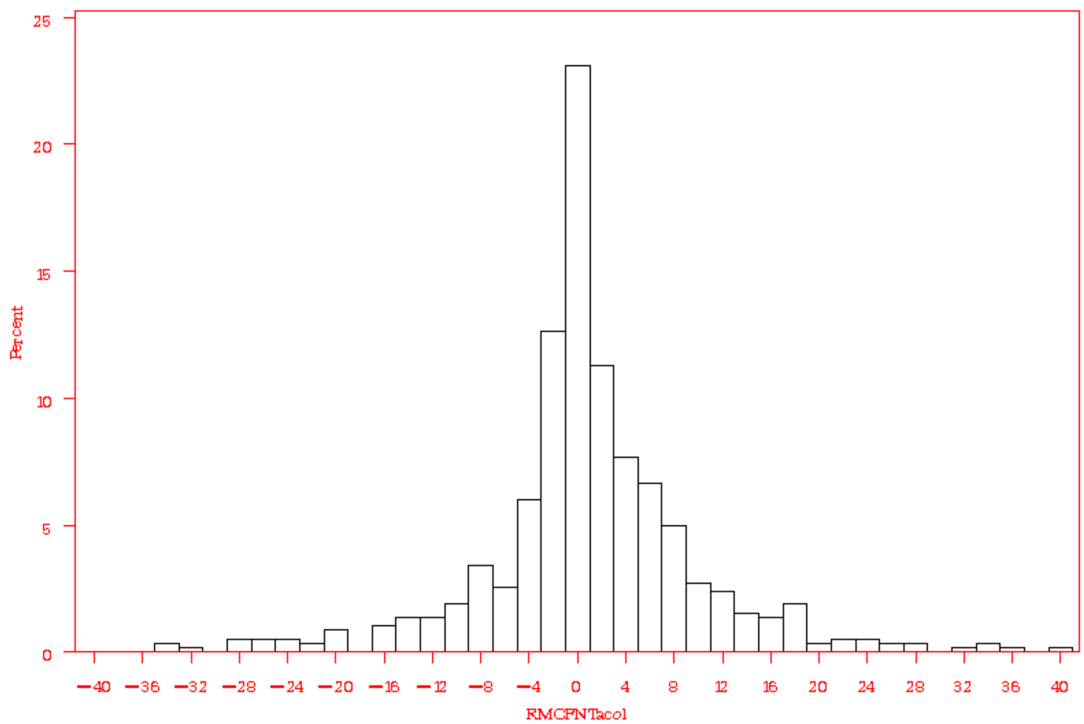
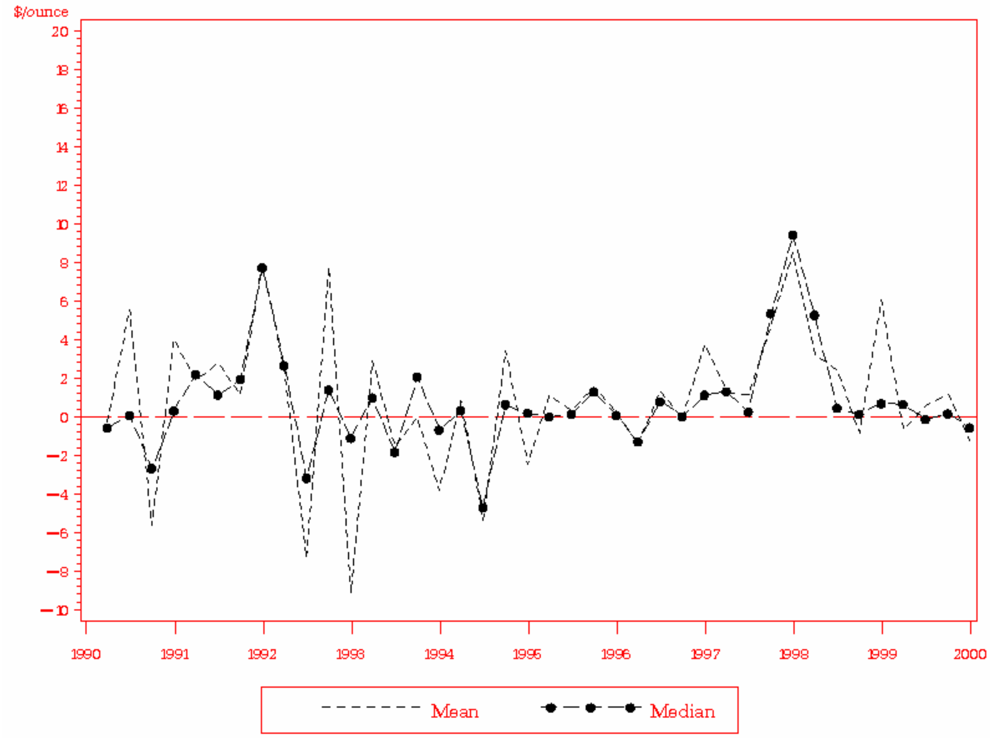


Figure 7

Selective Hedge Cash Flows (in US$ per ounce of gold hedged)

Selective Hedge Cash Flow based on Cragg Model



Selective Hedge Cash Flow based on Firm Average

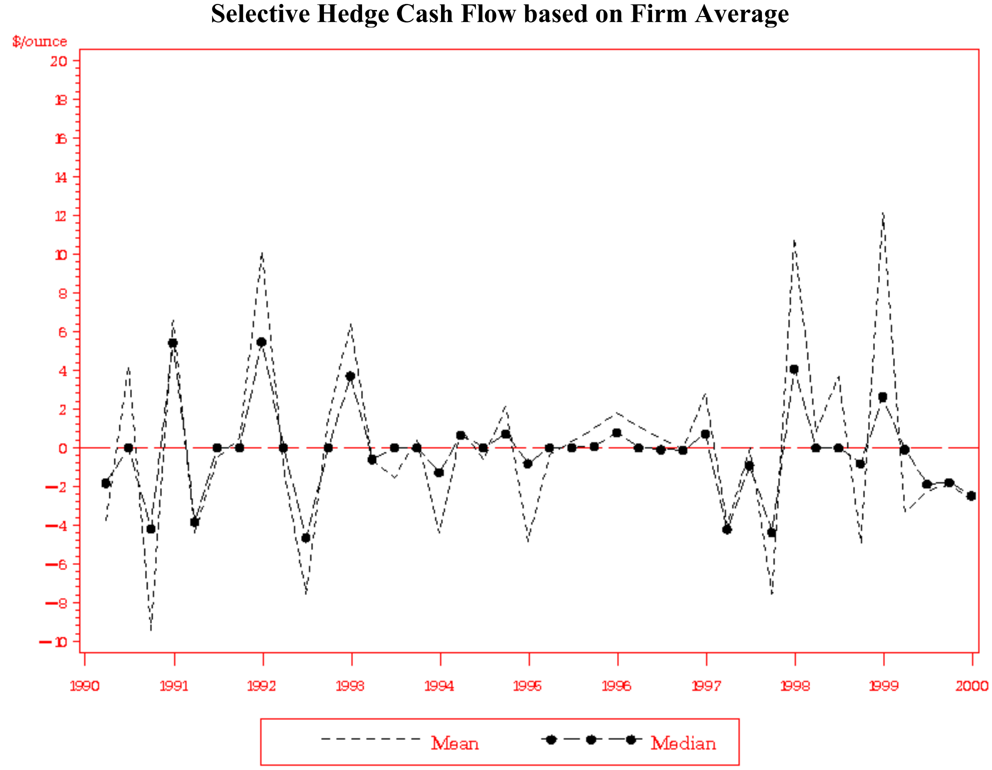


Table 1

Descriptive Statistics of Hedge Ratios and Hedge Ratio Volatilities

This table presents standard descriptive statistics of hedge ratios and volatilities of hedge ratios for each of the maturity ranges from 1 through 5 years. Hedge ratio means and medians are calculated from quarterly panel data Hedge ratio volatilities are calculated based on quarterly observations for each firm that use derivatives. Volatilities were calculated only if there were at least 12 positive hedge ratio observations.

Panel A: Descriptive statistics of hedge ratios of all firms in sample

	1-year hedge ratio	2-year hedge ratio	3-year hedge ratio	4-year hedge ratio	5-year hedge ratio
Mean	0.35	0.19	0.09	0.04	0.04
Median	0.23	0.03	0.00	0.00	0.00
Standard deviation	0.44	0.29	0.19	0.12	0.14
Observations	1986	1988	2006	2044	2063

Panel B: Descriptive statistics of hedge ratios of firms that hedge (industry average hedge ratios)

	1-year hedge ratio	2-year hedge ratio	3-year hedge ratio	4-year hedge ratio	5-year hedge ratio
Mean	0.48	0.26	0.13	0.06	0.05
Median	0.41	0.15	0.01	0.00	0.00
Standard deviation	0.45	0.31	0.21	0.14	0.17
Observations	1439	1441	1459	1497	1516

Panel C: Descriptive statistics of hedge ratios of firms that choose positive hedge ratios only

	1-year hedge ratio	2-year hedge ratio	3-year hedge ratio	4-year hedge ratio	5-year hedge ratio
Mean	0.54	0.36	0.25	0.20	0.28
Median	0.46	0.28	0.17	0.14	0.18
Standard deviation	0.45	0.31	0.24	0.20	0.31
Observations	1295	1030	744	439	261

Panel D: Descriptive statistics of hedge ratio volatilities (standard deviation of positive hedge ratios)

	1-year hedge ratio	2-year hedge ratio	3-year hedge ratio	4-year hedge ratio	5-year hedge ratio
Mean	0.28	0.19	0.14	0.11	0.15
Median	0.25	0.17	0.12	0.09	0.11
Observations	60	61	48	37	28

Table 2

Hedge Ratio Regressions

Panel A: Descriptive Statistics of Regressors

This panel contains descriptive statistics of the regressors used in the hedge ratio regressions in Panel B. The data consists of quarterly observations from December 1989 until December 1999. Firm size is defined as the book value of assets. The market-to-book ratio of assets equals the ratio of the market value of assets over the book value of assets. The market value equals the book value of assets minus the book value of common stock plus the market value of equity. Leverage is defined as the ratio of long-term debt plus preferred stock over long-term debt plus preferred stock plus common equity. Liquidity equals a firm's quick ratio. The dividend dummy equals one if a firm paid cash dividends during a fiscal year and zero otherwise. The credit rating dummy equals one if Standard and Poors had assigned a credit rating to a firm and zero otherwise.

	Mean	*Median*	*Std. Dev.*	*Min*	*Max*	*Obs.*
ln(firm size)	6.08	6.16	1.78	1.04	9.37	887
Market-to-book ratio of assets	1.85	1.57	1.10	0.42	9.08	887
Leverage	0.23	0.19	0.22	0	1.29	1283
Liquidity	3.88	1.87	8.39	0	99.5	1200
Dividend dummy	0.46	0	0.50	0	1	1745
Credit rating dummy	0.16	0	0.36	0	1	2258

Table 2 (contd.)

Panel B: Cragg Model Regressions

This panel presents the second stage regression results of the Cragg Model. The dependent variables are the 5 hedge ratios. We estimated the following regressions: ln(hedge ratio) = a + b*x + e. All regressions contain dummy variables for each quarter to control for seasonality in the data. The first stage consists of probit regressions to evaluate the decision to hedge. These probit regressions yielded the inverse Mill ratio, a necessary regressor for the second stage. Figures in parentheses denote t-statistics.

	1-year hedge ratio	2-year hedge ratio	3-year hedge ratio	4-year hedge ratio	5-year hedge ratio
ln(firm size)	0.512*** (3.93)	0.684*** (3.20)	0.631 (1.93)	-0.137 (-0.22)	1.140 (1.17)
Market-to-book ratio of assets	-0.446*** (-2.99)	-0.460** (-2.42)	-0.367 (-1.46)	0.455 (0.57)	-1.634 (-0.94)
Leverage	-0.407 (-1.12)	-0.177 (-0.57)	-0.332 (-0.66)	2.014 (0.84)	-1.224 (-0.43)
Liquidity	-0.092** (-2.40)	-0.034 (-0.93)	-0.101** (-2.01)	-0.079 (-1.22)	-0.214*** (-2.73)
Dividend dummy	-0.761*** (-5.02)	-0.883*** (-4.90)	-0.565** (-2.15)	0.109 (0.33)	-0.620 (-1.44)
Credit rating dummy	-0.248 (-1.61)	-0.392*** (-3.18)	-0.360 (-1.92)	-0.819 (-1.30)	1.655 (0.88)
Inverse Mills ratio	2.443** (2.24)	1.576 (1.67)	1.847 (1.38)	-1.421 (-0.55)	3.696 (0.85)
R^2	0.1548	0.1534	0.1076	0.1488	0.1855
F value	9.45	7.39	3.86	3.64	3.05
Obs.	527	419	331	219	145

*** and ** indicate significance at the one-percent and five-percent levels respectively.

Panel C: Descriptive statistics of predicted hedge ratios[32]

	1-year hedge ratio	2-year hedge ratio	3-year hedge ratio	4-year hedge ratio	5-year hedge ratio
Mean	0.38	0.29	0.21	0.16	0.20
Median	0.34	0.26	0.19	0.14	0.19
Standard deviation	0.16	0.13	0.08	0.07	0.10
Observations	527	419	331	219	145

[32] The predicted hedge ratios have also been estimated after outliers (top 1% of observations) were removed from the regressors. Since the two sets of predicted values were very similar, we conclude that outliers did not affect the regressions in a significant way.

Table 3

Summary Statistics and Significance Tests of Total Derivatives Cash Flows

This table presents standard summary statistics of the total quarterly cash flows associated with derivatives usage by our sample of firms. Figures are based on the pooled sample. Figures in parentheses denote p-values. We use a standard t-test to test whether the sample mean is zero. We use the Wilcoxon rank-sum test to test whether the median is zero.

Panel A: Firms that use derivatives, 1989 – 1999

	Units	Mean	Median	Standard deviation	Obs.
Total derivatives cash flows	$ (million)	2.73*** (0.000)	0.26*** (0.000)	18.75	1428
	$/hedged ounces	6.35*** (0.000)	3.42*** (0.000)	17.95	1428
	$/production ounces	3.36*** (0.000)	1.19*** (0.000)	13.61	1275

Panel B: Sub-period analysis

		Dec 1989 – Mar 1993 Falling gold prices	Mar 1993 – Mar 1996 Rising gold prices	Mar 1996 – Dec 1999 Falling gold prices
Total derivatives cash flows (Medians)	$ (million)	0.468*** (0.000)	0.001*** (0.000)	0.489*** (0.000)
	$/hedged ounces	7.10*** (0.000)	0.01** (0.020)	4.06*** (0.000)
	$/production ounces	2.30*** (0.000)	0.09*** (0.008)	1.63*** (0.000)

*** indicates significance at the one-percent level.

Table 4

Panel A: Summary Statistics of Predicted Hedge Ratio Benchmark Cash Flows

This panel presents standard summary statistics of the quarterly cash flows associated with five different benchmark hedging strategies: (i) predicted hedge ratios based on the Cragg Model (see Table 2), (ii) predicted hedge ratios based on the average hedge ratios of each firm over the sample period, (iii) predicted hedge ratios based on the industry average hedge ratios over the sample period, (iv) predicted hedge ratios based on an AR(4) model, and (v) predicted hedge ratios based on a four-period moving average (MA(4) model). Figures are based on the pooled sample of firms that use derivatives. Figures in parentheses denote p-values. We use a standard t-test to test whether the sample mean is zero and the Wilcoxon rank-sum test to test whether the median is zero.

Benchmark	Units	Mean	Median	Standard deviation	Obs.
Predicted hedge ratios based on *Cragg Model*	$ (million)	3.43*** (0.000)	0.14*** (0.000)	22.85	596
	$/hedged ounces	4.88*** (0.000)	1.41*** (0.000)	18.96	596
	$/production ounces	2.55*** (0.000)	0.38*** (0.000)	14.58	562
Predicted hedge ratios based on *firm average*	$ (million)	2.63*** (0.000)	0.24*** (0.000)	16.32	1432
	$/hedged ounces	6.14*** (0.000)	3.72*** (0.000)	19.63	1432
	$/production ounces	3.27*** (0.000)	1.09*** (0.000)	13.88	1278
Predicted hedge ratios based on *industry average*	$ (million)	1.45 (0.084)	0.28*** (0.000)	31.08	1374
	$/hedged ounces	6.30*** (0.000)	4.05*** (0.000)	19.67	1374
	$/production ounces	2.21*** (0.000)	0.95*** (0.000)	8.21	1277
Predicted hedge ratios based on *AR(4) model*	$ (million)	3.38*** (0.000)	0.29*** (0.000)	18.94	1062
	$/hedged ounces	5.66*** (0.000)	2.93*** (0.000)	19.29	1062
	$/production ounces	2.94*** (0.000)	0.93*** (0.000)	11.24	1001
Predicted hedge ratios based on *MA(4) model*	$ (million)	2.97*** (0.000)	0.15*** (0.000)	16.91	1027
	$/hedged ounces	5.40*** (0.000)	2.20*** (0.000)	20.07	1027
	$/production ounces	2.45*** (0.000)	0.50*** (0.000)	10.29	970

*** indicates significance at the one-percent level.

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Table 4 (contd.)

Panel B: Summary Statistics of Selective Hedge Cash Flows

This panel presents standard summary statistics of the quarterly selective hedge cash flows. The selective hedge cash flows are defined as the differences between the total derivatives cash flows and the benchmark cash flows (see Panel A for details). Figures are based on the pooled sample of firms that use derivatives. Figures in parentheses denote p-values. We use a standard t-test to test whether the sample mean is zero. We use the Wilcoxon rank-sum test to test whether the median is zero.

Benchmark	Units	Mean	Median	Standard deviation	Obs.
Predicted hedge ratios based on *Cragg Model*	$ (million)	0.81 (0.415)	0.09*** (0.001)	24.22	596
	$/hedged ounces	1.21** (0.022)	0.34*** (0.001)	12.86	596
	$/production ounces	1.47** (0.040)	0.31*** (0.000)	16.91	562
Predicted hedge ratios based on *firm average*	$ (million)	0.07 (0.868)	0.00 (0.4656)	15.38	1432
	$/hedged ounces	0.14 (0.691)	0.00 (0.274)	13.29	1432
	$/production ounces	0.07 (0.830)	0.02 (0.423)	11.85	1278
Predicted hedge ratios based on *industry average*	$ (million)	1.36 (0.136)	0.05*** (0.000)	33.86	1374
	$/hedged ounces	0.17 (0.649)	0.00 (0.311)	13.52	1374
	$/production ounces	1.13*** (0.001)	0.27*** (0.000)	12.01	1277
Predicted hedge ratios based on *AR(4) model*	$ (million)	-0.15 (0.804)	0.00 (0.790)	19.09	1062
	$/hedged ounces	0.39 (0.346)	0.03 (0.235)	13.30	1062
	$/production ounces	0.21 (0.586)	0.02 (0.925)	12.09	1001
Predicted hedge ratios based on *MA(4) model*	$ (million)	0.38 (0.541)	0.05*** (0.005)	19.73	1027
	$/hedged ounces	0.84 (0.070)	0.10** (0.041)	14.93	1027
	$/production ounces	0.77 (0.062)	0.21** (0.027)	12.84	970

*** and ** indicate significance at the one-percent and five-percent levels respectively..

Table 5

Benchmark and Selective Hedge Cash Flows in $/hedged ounce (Sub-Period Analysis)

This table presents sample medians of the benchmark and selective hedge cash flows in US$/ounce of gold hedged for three sub-periods. Figures are based on the pooled sample of firms that use derivatives. Figures in parentheses denote p-values. We use the Wilcoxon rank-sum test to test whether the medians are zero.

	Benchmark	Dec 1989 – Mar 1993 Falling gold prices	Mar 1993 – Mar 1996 Rising gold prices	Mar 1996 – Dec 1999 Falling gold prices
Predicted hedge cash flows	*Cragg Model*	4.45*** (0.000)	0.00 (0.097)	1.67*** (0.000)
	Firm average hedge ratios	7.33*** (0.000)	0.25 (0.171)	5.49*** (0.000)
	Industry average hedge ratios	7.91*** (0.000)	0.09 (0.281)	5.86*** (0.000)
	AR(4) model	3.70*** (0.000)	0.56** (0.049)	5.02*** (0.000)
	MA(4) model	4.19*** (0.000)	0.32 (0.173)	4.26*** (0.000)
Selective hedge cash flows	*Cragg Model*	1.05** (0.011)	0.00 (0.967)	0.65*** (0.005)
	Firm average hedge ratios	0.00 (0.924)	0.00 (0.421)	-0.13 (0.055)
	Industry average hedge ratios	0.00 (0.508)	0.12 (0.225)	-0.25 (0.157)
	AR(4) model	0.51** (0.027)	0.01 (0.799)	0.00 (0.943)
	MA(4) model	0.52** (0.013)	0.00 (0.827)	0.07 (0.318)

*** and ** indicate significance at the one-percent and five-percent levels respectively.

Table 6

Risk Premia in the Gold Market

Panel A: Realized Risk Premia: 1979 – 2003

This panel reports the average realized risk premia (means) in the gold market during 1979-2003. The risk premium is defined as the difference between the futures price at time t, denoted by F(t,T), and the spot price at time T, denoted by S(T). We express the risk premium both as an annualized dollar figure, i.e., [F(t,T) – S(T)]/T, and as an annualized return figure, i.e., [1 + (F(t,T) – S(T))/F(t,T)]^(1/(T-t)) – 1, for (T-t) = 1,2,3,4,5 years. We estimated the risk premia using measurements at both monthly and quarterly intervals. The results were virtually identical. Therefore, we report only the monthly results. Figures in parentheses denote t-statistics.

Hedge horizon (T-t) in years	Risk Premium (in US$)		Risk Premium (in %)	
	Obs.	Mean	Obs.	Mean
1	272	24.99*** (4.35)	272	3.43** (2.34)
2	260	36.00*** (10.49)	260	5.81*** (8.90)
3	247	39.62*** (15.36)	247	6.50*** (20.12)
4	235	42.11*** (16.80)	235	6.24*** (24.87)
5	223	44.76*** (19.37)	223	6.16*** (40.02)

*** and ** indicate significance at the one-percent and five-percent levels respectively.

Panel B: Determinants of Realized Risk Premia (based on returns of one-year futures held to maturity)

This panel presents OLS regressions to document the correlations between the risk premium in the gold market and several risk factors during 1979-2003. The dependent variable is the one-year realized risk premium, i.e., [F(t,T) – S(T)]/F(t,T), where T-t = 1 year. Similar results were obtained from 2, 3, 4, and 5-year realized risk premia. The regressors are the three Fama-French factors, and the gold return. The regressions are based on measurements at monthly intervals. Standard errors are adjusted for serial correlation due to overlapping observations following Hansen and Hodrick (1980). Figures in parentheses denote t-statistics.

	Intercept	Market Return	SML	HML	Gold Return	Obs.	R^2
I	0.059*** (10.09)				-0.913*** (-58.77)	271	0.98
II	0.058*** (9.51)	0.013 (0.52)			-0.914*** (-58.35)	271	0.98
III	0.057*** (8.58)	0.013 (0.43)	0.032 (0.80)	0.004 (0.12)	-0.916*** (-58.91)	271	0.98

*** and ** indicate significance at the one-percent and five-percent levels respectively.

Table 6 (contd.)

Panel C: Determinants of Realized Risk Premia (based on monthly futures returns)

This panel presents OLS regressions to document the correlations between the risk premium in the gold market and several risk factors during 1979-2003. Here we follow Bessembinder (1992), and define the dependent variable as the monthly return on a short position in the shortest-maturity gold futures contract available, i.e., [F(t) – F(t-1)]/F(t-1). Bessembinder uses an equivalent definition to measure the returns on long futures positions. The regressors are the three Fama-French factors, and the gold return. The regressions are based on monthly data. Figures in parentheses denote t-statistics.

	Intercept	Market Return	SML	HML	Gold Return	Obs.	R^2
I	0.0052*** (5.86)				-0.981*** (-61.34)	285	0.93
II	0.0051*** (5.73)	-0.012 (-0.62)			-0.982*** (-61.20)	285	0.93
III	0.0050** (5.48)	0.017 (0.74)	0.013 (0.45)	0.017 (0.50)	-0.983*** (-60.69)	285	0.93

*** and ** indicate significance at the one-percent and five-percent levels respectively.

Table 7

The Impact of Hedging on Firms' Stock Market Betas (with firm fixed effects)

The dependent variable in all regressions is a firm's annual stock market beta, estimated from a standard market model, $R_i = \alpha + \beta R_m + \varepsilon$, using daily excess returns. We use the CRSP NYSE/AMEX/Nasdaq composite value-weighted index as the market portfolio for companies listed in the U.S., and the CFMRC value-weighted index for companies listed only in Canada. We regress the estimated stock market betas on firms' hedge ratios and several control variables. Firm size equals the book value of assets, leverage is defined as the ratio of long-term debt plus preferred stock over long-term debt plus preferred stock plus common equity, and the two diversification variables represent Herfindahl indices based on the value of assets in different business segments, and the value of production of different metals. All regressions contain fixed effects. Sample contains only firms that hedge. Figures in parentheses denote t-statistics.

Panel A1: Dependent Variable: Firms' Stock Market Beta

No.	1-year hedge ratio	2-year hedge ratio	3-year hedge ratio	4-year hedge ratio	5-year hedge ratio	Obs.	R^2 (within)
I	0.054 (0.31)					309	0.000
II		-0.129 (-0.64)				316	0.002
III			-0.509 (-1.90)			316	0.015
IV				0.190 (0.43)		318	0.001
V					0.232 (0.69)	319	0.002

Panel B1: Control Regressions

x	x-year hedge ratio	ln(firm size)	Leverage	Assets diversification	Production diversification	Obs.	R^2 (within)
1	0.117 (0.61)	0.171 (1.51)	1.208** (3.32)	-0.256 (-0.27)	0.411 (0.72)	216	0.097
2	-0.282 (-1.34)	0.164 (1.44)	1.624** (4.63)	-0.294 (-0.31)	0.523 (0.97)	221	0.144
3	-0.031 (-0.10)	0.151 (1.30)	1.570** (4.32)	-0.398 (-0.42)	0.466 (0.86)	220	0.135
4	0.396 (0.88)	0.143 (1.24)	1.545** (4.42)	-0.426 (-0.45)	0.468 (0.87)	220	0.139
5	0.576 (1.08)	0.085 (0.58)	0.970** (2.23)	1.963 (1.70)	0.427 (0.63)	221	0.065

*** and ** indicate significance at the one-percent and five-percent levels respectively.

Table 7 (contd.)

The Impact of Hedging on Firms' Stock Market Betas (without fixed effects)

The dependent variable in all regressions is a firm's annual stock market beta, estimated from a standard market model, $R_i = \alpha + \beta R_m + \varepsilon$, using daily excess returns. We use the CRSP NYSE/AMEX/Nasdaq composite value-weighted index as the market portfolio for companies listed in the U.S., and the CFMRC value-weighted index for companies listed only in Canada. We regress the estimated stock market betas on firms' hedge ratios and several control variables. Firm size equals the book value of assets, leverage is defined as the ratio of long-term debt plus preferred stock over long-term debt plus preferred stock plus common equity, and the two diversification variables represent Herfindahl indices based on the value of assets in different business segments, and the value of production of different metals. Sample contains only firms that hedge. Figures in parentheses denote t-statistics.

Panel A2: Dependent Variable: Firms' Stock Market Beta

No.	1-year hedge ratio	2-year hedge ratio	3-year hedge ratio	4-year hedge ratio	5-year hedge ratio	Obs.	R^2
I	-0.011 (-0.08)					309	0.000
II		0.032 (0.15)				316	0.000
III			-0.444 (-1.53)			316	0.013
IV				-0.092 (-0.29)		318	0.000
V					0.305 (1.27)	319	0.002

Panel B2: Control Regressions

x	x-year hedge ratio	ln(firm size)	Leverage	Assets diversification	Production diversification	Obs.	R^2
1	0.063 (0.58)	0.005 (0.10)	0.220 (0.79)	-1.169*** (-3.20)	-1.141 (-0.46)	224	0.140
2	0.148 (0.69)	0.014 (0.26)	0.183 (0.59)	-1.165*** (-3.47)	-0.188 (-0.61)	229	0.140
3	0.219 (1.01)	0.011 (0.20)	0.197 (0.64)	-1.194*** (-3.57)	-0.159 (-0.52)	228	0.140
4	0.561 (1.56)	0.005 (0.09)	0.228 (0.73)	-1.240*** (-3.72)	-0.121 (-0.40)	228	0.144
5	0.726** (2.26)	0.029 (0.53)	0.150 (0.50)	-1.027** (2.65)	-0.206 (-0.63)	229	0.101

*** and ** indicate significance at the one-percent and five-percent levels respectively.

Table 8

Determinants of Selective Hedge Cash Flows

Panel A: Selective hedge cash flow regressions
This panel presents OLS regression results of the selective hedge cash flows per ounce of gold hedged. We estimate the following five regressions:

Selective hedge cash flow = a + b×hedge ratio(x) + c×hedge ratio(x)^2 + d×hedge ratio volatility(x) + realized one-year risk premium + e,

where x = 1,2,3,4,5 refers to the maturity of the hedge in years. The selective hedge cash flows are computed using the predicted hedge ratio based on the Cragg model. Figures in parentheses are t-statistics.

	Dependent variable: Selective hedge cash flow per ounce of gold hedged (Cragg Model)				
	x = 1	x = 2	x = 3	x = 4	x = 5
Intercept	0.30 (0.22)	2.24** (2.17)	3.39*** (3.11)	4.17*** (4.20)	2.35** (2.31)
Hedge ratio (x)	1.353 (0.62)	-3.01 (-1.22)	-6.13 (-1.09)	-9.91 (-1.26)	-7.58 (-1.80)
Hedge ratio (x) squared	-1.064 (-0.89)	-0.188 (-0.12)	3.023 (0.46)	10.52 (0.96)	3.79 (1.44)
Hedge ratio volatility (x)	3.83 (1.01)	0.84 (0.20)	-0.88 (-1.47)	-17.47*** (-2.62)	-4.88 (-1.15)
Risk premium	27.73*** (4.97)	30.07*** (5.25)	28.55*** (4.74)	27.44*** (4.21)	21.45*** (3.14)
Adj. R^2	0.022	0.028	0.030	0.033	0.017
F value (p-value)	6.51 (0.000)	8.05 (0.000)	7.90 (0.000)	7.53 (0.000)	3.66 (0.006)
# Obs.	1000	993	885	762	580

*** and ** indicate significance at the one-percent and five-percent levels respectively.

Panel B: Hedge ratio residuals regressions
This panel presents the regression results of the standardized difference between the actual and the predicted hedge ratios, i.e., the standardized residuals from the Cragg Model estimations in Table 2, on the next period gold return. Figures in parentheses denote t-statistics.

	1-year hedge ratio (t)	2-year hedge ratio (t)	3-year hedge ratio (t)	4-year hedge ratio (t)	5-year hedge ratio (t)
Intercept	-0.0007 (-0.02)	0.0008 (0.02)	-0.004 (-0.07)	0.003 (0.04)	0.018 (0.19)
Gold return (t+1)	-0.0714 (-0.10)	0.1031 (0.12)	-0.7448 (-0.76)	0.36 (0.28)	1.79 (1.17)
Adj. R^2	-0.002	-0.002	-0.001	-0.004	0.003
Obs.	526	418	330	218	144

*** and ** indicate significance at the one-percent and five-percent levels respectively.

Table 9
Binomial Tests of Persistence

This table lists the probabilities that a firm's selective hedge cash flows are positive/negative in period t conditional on the firm's selective hedge cash flows being positive/negative in period t-1 (the previous quarter). The null hypothesis is that the probabilities equal ½. p-values are based on the Binomial Exact Test. Values significant at the 5% level or higher are displayed in bold face.

	Cash flow negative at t-1			Cash flow positive at t-1		
Date	Prob. of *positive* cash flow at t	Prob. of *negative* cash flow at t	p-value	Prob. of *positive* cash flow at t	Prob. of *negative* cash flow at t	p-value
199006	62.50%	37.50%	0.7266	40.00%	60.00%	1
199009	46.15%	53.85%	1	**16.67%**	**83.33%**	**0.0386**
199012	**84.21%**	**15.79%**	**0.0044**	55.56%	44.44%	1
199103	40.00%	60.00%	1	**26.09%**	**73.91%**	**0.0347**
199106	54.55%	45.45%	0.8318	57.14%	42.86%	1
199109	57.14%	42.86%	0.7905	37.50%	62.50%	0.4545
199112	**93.75%**	**6.25%**	**0.0005**	71.43%	28.57%	0.1796
199203	60.00%	40.00%	1	36.36%	63.64%	0.2863
199206	25.00%	75.00%	0.0768	10.00%	90.00%	0.0215
199209	59.09%	40.91%	0.5235	20.00%	80.00%	0.375
199212	**100.00%**	**0.00%**	**0.0001**	58.33%	41.67%	0.7744
199303	50.00%	50.00%	1	20.00%	80.00%	0.0118
199306	63.16%	36.84%	0.3593	50.00%	50.00%	1
199309	56.25%	43.75%	0.8036	37.50%	62.50%	0.4545
199312	37.50%	62.50%	0.4545	**14.29%**	**85.71%**	**0.0129**
199403	**75.00%**	**25.00%**	**0.0414**	71.43%	28.57%	0.4531
199406	42.86%	57.14%	1	47.06%	52.94%	1
199409	**84.62%**	**15.38%**	**0.0225**	53.85%	46.15%	1
199412	50.00%	50.00%	1	**20.00%**	**80.00%**	**0.0118**
199503	59.09%	40.91%	0.5235	14.29%	85.71%	0.125
199506	46.67%	53.33%	1	58.82%	41.18%	0.6291
199509	50.00%	50.00%	1	55.56%	44.44%	0.8145
199512	**87.50%**	**12.50%**	**0.0042**	55.56%	44.44%	0.8145
199603	70.00%	30.00%	0.3437	39.13%	60.87%	0.4049
199606	50.00%	50.00%	1	42.11%	57.89%	0.6476
199609	36.84%	63.16%	0.3593	38.46%	61.54%	0.5811
199612	66.67%	33.33%	0.1892	61.54%	38.46%	0.5811
199703	30.77%	69.23%	0.2668	14.29%	85.71%	0.0015
199706	48.00%	52.00%	1	40.00%	60.00%	0.7539
199709	30.43%	69.57%	0.0931	**12.50%**	**87.50%**	**0.0042**
199712	68.97%	31.03%	0.0614	62.50%	37.50%	0.7266
199803	66.67%	33.33%	0.5078	47.83%	52.17%	1
199806	61.11%	38.89%	0.4807	46.67%	53.33%	1
199809	33.33%	66.67%	0.3018	29.41%	70.59%	0.1435
199812	**77.27%**	**22.73%**	**0.0169**	50.00%	50.00%	1
199903	44.44%	55.56%	1	30.00%	70.00%	0.1153
199906	35.29%	64.71%	0.3323	27.27%	72.73%	0.2266
199909	29.41%	70.59%	0.1435	40.00%	60.00%	0.7539
199912	27.78%	72.22%	0.0963	42.86%	57.14%	0.7905
Average	***55.44%***	***44.56%***	***0.4963***	***39.79%***	***60.21%***	***0.5185***