Are There Speculative Components in Corporate Hedging and Do They Add Value?

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ABSTRACT

Why does corporate risk management add value? A common hypothesis is that derivatives transactions have zero NPV, and add value only because they help firms mitigate market imperfections. We reexamine this question by analyzing the derivatives transactions of 92 North American gold mining firms from 1989-1999. Our data allows us to infer the quarterly cash flows that each firm derives specifically from its derivatives transactions. Surprisingly, we find that these cash flows are positive, and both economically and statistically significant. Our sample firms realized an average gain of $2.73 million per quarter from their derivatives transactions, while their average quarterly net income was only $0.87 million. These gains appear to be the result of systematic positive risk premia in the gold market. Furthermore, we find evidence that is consistent with firms incorporating their market views into their hedging programs. However, we find that speculating on the time variation of the risk premium has not created any value for shareholders on average. To our knowledge, ours is the first study to show that corporate derivatives usage can be intrinsically valuable, and our results highlight a potentially important motive for the corporate use of derivatives that the literature has hitherto ignored.

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.

These 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, hedging is thought to add value because it alleviates a variety of market imperfections encountered by a firm. Why then do some firms believe that "hedging" (as in the case of Placer Pacific) or "not hedging" (as in the case of Franco-Nevada) can directly enhance their revenues? One possible explanation of this phenomenon is that firms use derivatives to speculate on persistent risk premia that cause forward prices to deviate from expected future spot prices.[1] Additionally, some firms may believe that they can time the market, possibly due to inside information or unique knowledge of their industry.[2]

Can managers create value for shareholders by incorporating such speculative elements into their hedging programs? This question, although fundamental to the literature on risk management, has received scant attention in the literature, possibly due to the lack of adequate firm-specific data on derivatives usage.[3] Meanwhile, the assumption that derivatives

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[1] 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 Franch (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.

[2] See for example Stulz (1996), Graham and Harvey (2001), and Baker and Wurgler (2002).

[3] Brown, Crabb and Haushalter (2002) examine whether firms add value by hedging "selectively," i.e. varying their hedge ratios over time, and find no evidence that they do.

transactions by themselves do not produce positive cash flows on average, and that a firm derives all its hedging benefits from the alleviation of market imperfections remains a basic tenet in the risk management literature.

We address the question of whether corporate speculation adds value using a unique database that contains quarterly observations on all outstanding gold derivatives positions of a sample of 92 North American gold mining firms from 1989-1999.[4] 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 earn positive cash flows from the use of derivatives, which are highly significant both economically and statistically. Our sample firms realized an average gain of $2.73 million per quarter from their derivatives transactions, while their average quarterly net income was only $0.87 million. The aggregate hedging gain across all firms in our sample exceeded $3.9 billion during the 1989-1999 period. The entire cash flow benefit from the use of derivatives appears to stem from systematic positive risk premia in the gold market, i.e. forward prices that systematically exceed future spot prices. Firms gain on average $6 per ounce of gold hedged. Finally, we find considerable volatility in firms' hedge ratios over time, which may be due to firms incorporating their market views into their

[4] Hedging activity in the gold mining industry has been extensively studied in the literature. See, for example, Tufano (1996, 1998), 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.

hedging programs (selective hedging). However, we find that this form of speculation has not created any value for shareholders on average.[5]

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 on average, can be violated for an extended period. Second, we highlight that risk premia in derivatives markets can be a potentially important motive for the corporate use of derivatives. Finally, our analysis shows that disregarding the intrinsic cash flow effects of derivatives usage will lead to the erroneous measurement of hedging benefits arising from the alleviation of market imperfections.

Theoretical models of corporate hedging have been built up 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.[6] However, many financial managers seem to believe that they are able to create additional value by building speculative components into their hedging programs.[7] Survey results and extensive anecdotal evidence suggest that a majority of financial managers at least sometimes incorporate their market views into their hedging programs.[8] There is also a growing literature

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[5] While the term "selective hedging" has been applied in the literature to imply corporate speculation by firms varying their hedge ratios over time, we show that it is also possible for a firm to speculate on expected systematic deviations of the forward price from the future spot price while keeping its hedge ratio fixed.

[6] 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 motivations for corporate risk management.

[7] Stulz (1996) attempts to reconcile the practice of hedging based on market views with existing theory by proposing a theory of risk management that focuses on comparative advantage in risk bearing. He argues that some companies may have a comparative advantage in bearing certain financial market risks based on possessing superior information.

[8] See the recent surveys by Dolde (1993) of U.S. Fortune 500 firms and by Bodnar, Hayt and Marston (1998) of derivatives usage by U.S. non-financial firms. In a survey of 13 gold mining firms by Adam (2000), eight firms reported that their expectation about future metal prices is a very important or fairly important factor that determines the extent to which they hedge. We have also collected similar anecdotal evidence from other gold mining firms.

that provides evidence of selective hedging in a variety of financial settings.[9] A policy of corporate speculation within a hedging program implies at least two potential speculative components: (a) that managers will determine the size of a hedge based in part on their expectation of the risk premium, i.e. the spread between the forward price and the expected future spot price, and (b) that managers will vary the size of the hedge dynamically (i.e. engage in "selective" hedging) as they update their market expectations over time. We refer to "(a)" and "(b)" as *fixed* and *time varying* speculation, respectively.

Our findings shed new insight into the question of whether firms can create value by incorporating speculative components in hedging, on which there is currently very little evidence. In a recent study, Brown, Crabb and Haushalter (2002) examine whether time varying speculation adds value in a sample of 48 firms drawn from three industries, including 44 gold producers. They argue that managers' market views appear to have an impact on hedging strategies as measured by the time-series variation of a firm's hedge ratio. For gold producers, they find that hedge ratios increase when gold prices increase, and vice versa. However, they find that the potential economic benefit of this selective hedging in their sample is quite small. Brown, Crabb and Haushalter (2002) do not measure the total cash flow effects of hedging as we do. Additionally, our sample is considerably larger. Nonetheless, our findings about the effects of time varying speculation are the same: it does not add value. Despite considerable variation in hedge ratios over time, firms do not seem to be able to successfully time the market. Nonetheless, it is very clear that gold producers who sold gold forward using derivatives benefited handsomely from a persistent positive risk premium in the gold market. We are unable to rule out the possibility that this benefit stems in part from these

[9] See for example Brown, Crabb and Haushalter (2002), and Naik and Yadav (2002) for some recent evidence.

firms deliberately incorporating a fixed speculative component in their hedging programs to exploit the risk premium. While continually selling short is a risky strategy for pure speculators, gold mining firms have a comparative advantage in capturing the benefits of a positive risk premium due to their inherent long position in gold.

Our work is also related to a recent study by Hentschel and Kothari (2001) who use a stock market measure of derivatives use to 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 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 relevant for empirical studies on why firms hedge. Existing empirical studies reflect the standard theoretical view that expected risk premia are zero and there is no speculative element in corporate hedging programs.[10] 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. It is not clear whether the value increase stems from the alleviation of market imperfections or from risk premia in forward markets, with or without corporate speculation. Our methodology permits a

[10] 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.

separation of these components. Indeed, while our study also reveals a positive relationship between a firm's cash flow gain and derivative usage, this relationship is entirely due to the risk premia in the gold forward market.[11]

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 hedging cash flows from income statements, relying on the footnotes to determine whether hedging 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 I we examine how the existence of risk premia may affect firms' hedging strategies and review the evidence on the presence of speculative components in hedging. Section II describes the sample of gold

[11] Obviously, since we do not measure benefits associated with reducing frictions, we cannot rule out the possibility that they too exist for our sample of firms.

mining firms that we use in our study and the data set employed in our analysis. Section III presents our evidence on the existence of time varying speculation in our sample. Section IV presents our findings on the gains from hedging and time varying speculation. Section V concludes.

I. Speculative Components in Corporate Hedging

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 zero speculative returns to derivatives use, which would be the case if the "unbiased expectations hypothesis" holds, i.e. the forward price equals the market's expectation of the future spot price, making the expected value of a forward contract equal to zero. However, numerous studies have documented contradictory evidence. Hansen and Hodrick (1980) find evidence to reject 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 not unbiased 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 and the junk bond premium. They attribute this forecastability to time-varying risk premia in futures prices. Risk premia in futures markets can be both positive and negative, and Hirshleifer (1989) and Bessembinder (1992) review the extensive theoretical literature on their determinants.

If the unbiased expectations hypothesis does not hold, corporations may use derivatives not only for hedging purposes but also to benefit from persistent risk premia. In this case, derivatives could add value not only by mitigating market imperfections but also by generating positive cash flows on average. Alternatively, even when firms use derivatives purely for hedging, the presence of risk premia could confound the effects of derivatives use. 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.

A. Existing Evidence

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. Naik and Yadav (2002) examine the interest rate risk management practices of bond dealers in the UK government bond market. They find that dealers engage in selective risk taking by a policy of duration targeting.

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 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. This evidence is supported by anecdotal evidence that we have collected from corporate reports. The following extracts complement the two we cited in the introduction to this paper:

> 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).

> We are reducing … our (hedging) program, given … our positive view of the gold price. (**Barrick Gold Corporation**, Annual Report 2002).

These statements are consistent with the existence of a persistent risk premium in the gold market and the use of hedging strategies to benefit from it. We next consider the potential derivatives cash flow components associated with such strategies.

B. 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* incorporated in *F(t,T)* can be expressed as:

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

In general, the expected risk premium will consist of both fixed and time varying components.

Suppose the firm sells a fraction *H(t,T)* ("hedge ratio") of its production forward at the forward price of *F(t,T)*. Consider first the case in which the expected risk premium at time *t*, $E_t[R(t,T)]$ is zero. In this case, the firm will choose a hedge ratio $H(t,T) = H^P(t,T)$, where $H^P(t,T)$ is chosen based purely on the firm's hedging considerations, i.e. devoid of any speculative motive. Consider next the case in which $E_t[R(t,T)] > 0$. In this case, a firm that decides to exploit the expected positive risk premium would choose a hedge ratio $H(t,T) > H^P(t,T)$. Similarly, if $E_t[R(t,T)] < 0$, the firm would choose a hedge ratio $H(t,T) < H^P(t,T)$. Thus, when the firm speculates on the expected risk premium, *H(t,T)* will increase monotonically with the expected risk premium and we can decompose *H(t,T)* into two components: $H^P(t,T)$ (the *hedging component*) and $H^S(t,T)$ (the *speculative component*), where $H^S(t,T)$ is given by

$$H^S(t,T) = 0 \ \textit{if} \ \ E_t[R(t,T)] = 0$$
$$= H(t,T) - H^P(t,T) \ \textit{otherwise.}$$

If the expected risk premium consists of both fixed and time-varying components, then $H^S(t,T)$ will also consist of *fixed* and *time varying components*. Thus, we can express $H^S(t,T)$ as:

$$H^S(t,T) = \bar{H}^S + \Delta H^S(t,T)$$

where $\bar{H}^S$, the *fixed speculative component* is the mean of $H^S(t,T)$ over the sample period, and $\Delta H^S(t,T)$, the *time varying speculative component* is the variation of $H^S(t,T)$ around the mean during the sample period. Additionally, we assume that $H^P(t,T)$ is fixed over the sample period, i.e. $H^P(t,T) = \bar{H}^P$. Thus,

$$H(t,T) = \bar{H}^P + \bar{H}^S + \Delta H^S(t,T) .$$

For a forward sale at time *t* of a fraction *H(t,T)* of the firm's production to be delivered at time *T*, we can identify three distinct cash flows that correspond to the three hedge ratio components:

i. Hedging cash flow arising from the *hedging component*: $\bar{H}^P \left[F(t,T) - S(T)\right]$.

ii. Speculative cash flow arising from the *fixed speculative component*: $\bar{H}^S \left[F(t,T) - S(T)\right]$.

iii. Speculative cash flow arising from the *time varying speculative component*: $\Delta H^S(t,T) \left[F(t,T) - S(T)\right]$.

The separation of hedge ratios and derivatives cash flows into hedging and speculative components provides the basis for our empirical analysis. First, it is possible to detect time varying speculation ("selective hedging") by examining the time series variation of hedge ratios. In contrast, any fixed component of speculation cannot be empirically detected since it is not possible to identify the two fixed components $\bar{H}^P$ and $\bar{H}^S$ separately. We refer to $\bar{H}^P + \bar{H}^S = \bar{H}$ as the *fixed hedge ratio component.* We analyze the time series variation of hedge ratios in Section III for evidence of speculation. Second, corresponding to $\Delta H^S(t,T)$ and $\bar{H}$ we can empirically identify two derivatives cash flow components, which we refer to as *fixed hedge* cash flow and *variable speculative* cash flow, respectively. Under the null hypothesis of zero risk premia, neither of these cash flows would be significantly different from zero. Significantly positive variable speculative cash flows would provide evidence that firms are successful at speculating on the time series variation of risk premia, even in the case of risk premia that are zero on average. In contrast, while fixed hedge cash flows that are significantly different from zero would be consistent with the presence of non-zero average risk premia, we are unable to make inferences about any fixed speculative component that might exist. We analyze derivatives cash flows in Section IV.

II. 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. Table I presents some descriptive statistics about the sample of firms for 1989-1998.

[Place Table I about here]

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 maturities interest rates (1-month to 7-year rates) are from the Federal Reserve Statistical Release H.15. The gold lease rate has been provided by Scotia McLeod on a monthly basis until Dec. 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. Operational data, e.g. gold production figures, production costs per ounce of gold, is collected by hand from firms' financial statements.

III. Analysis of Hedge Ratios

In this section, we study the hedging behavior of our sample of firms for evidence of speculative activity in their hedging programs. In particular, we analyze the behavior of hedge

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

ratios over time for evidence of time varying speculation. Brown, Crabb and Haushalter (2002) examine the time series volatility of the hedge ratios of 44 gold producers. They find the volatility to be too high to be explained by changes in firms' financial or operating characteristics, and therefore attribute the excess volatility to selective hedging (firms incorporating their market views into their hedging programs). Following Brown, Crabb and Haushalter (2002) we examine the time series behavior of hedge ratios for our sample of firms. The hedge ratio is the fraction of the future expected gold production that has been hedged. 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.

$$x\text{–}year\ \ hedge\ \ ratio = \frac{-Portfolio\ \ delta\ \ (x\ \ year\ \ contracts)}{Expected\ \ production\ \ (x\ \ years\ \ ahead)},\ \text{where}\ \ x = 1, 2, 3, 4, 5.$$

Next we calculate the volatility (standard deviation) of all five hedge ratios for each firm where we observe at least 12 non-zero hedge ratios. Table II provides descriptive statistics for the five hedge ratios, including and excluding firms that do not use derivatives during the sample period.

[Place Table II 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. As in Brown, Crabb and Haushalter (2002), we observe that hedge ratios are highly volatile. The one-year hedge ratio has a mean (median) volatility of 0.28 (0.25), while the five-year hedge ratio has a mean (median) volatility of 0.15 (0.11).

Figure 1 provides time series plots of mean and median hedge ratios. There is no apparent time trend in hedge ratios, despite some seasonality (hedge ratios tend to be lowest in the December surveys and highest in the September surveys). However, 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]

Anecdotal evidence and the findings of Brown, Crabb and Haushalter (2002) suggest that current gold prices may influence hedging decisions in the gold mining industry. We regress changes in hedge ratios on changes in the gold price to determine whether firms adjust their hedges in response to changes in gold prices. Regressions are also run on levels. The results are reported in Table III.

[Place Table III about here]

We observe positive relationships between changes in hedge ratios and changes in gold prices, which are statistically significant at the 1% level for one and two-year hedge ratios. This suggests that as gold prices increase, gold mining firms increase their level of hedging, and vice versa. This evidence is consistent with time varying speculation, since firms that believe gold prices will revert to their historical means would want to lock in their future selling prices when gold prices are high, whereas they would try to preserve their upside when prices are low. The corresponding results for three, four and five-year hedge ratios also have the correct sign although only the four-year result is statistically significant (at the 10% level).

In contrast, when we compare levels we observe that hedge ratios are higher at low gold prices than at high gold prices. While this result also suggests that the level of hedging depends on market prices, in this case our finding is better explained by firms using hedging for relief from financial constraints that they are more likely to experience at low gold prices.

Overall, we can conclude that the variation in the hedge ratios over time is consistent with speculation. We next turn to the analysis of cash flow impacts associated with incorporating speculative components in hedging.

IV. Analysis of Derivatives Cash Flows

In this section, we first examine the cash flow impact of firms' derivatives activities. Second, we investigate the origins of the value gains or losses from using derivatives. To do this we divide each firm's total derivatives cash flow into two components, (i) the cash flow that a firm would have received had it maintained a constant hedge ratio (equal to the firm's average hedge ratio) throughout the sample period, which we call the fixed hedge cash flow, and (ii) the difference between the total derivatives cash flow and the fixed hedge cash flow, which we call the variable speculative ("selective hedging") cash flow.

A. Total derivatives cash flows

As noted in Section I, if a firm does not have the ability to exploit time varying risk premia and/or if average risk premia are zero, the average total derivatives cash flow over the sample period should be zero. A non-zero figure would indicate that there is either a persistent non-zero risk premium, or firms are able to profit from time varying risk premia, or both. Table IV reports descriptive statistics of the total cash flow associated with derivatives usage.

[Place Table IV 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 the 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 per ounce of gold hedged, or \$3 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.

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 cash flows across firms plotted in Figure 2.

[Place Figure 2 about here]

Figure 3 plots the total derivatives cash flows (industry mean and median) over time. The graph shows that firms generated significant cash flows off their hedging strategies, except for a relatively brief period from mid 1993 to mid 1995. This period coincided with a period when gold prices were generally rising.

[Place Figure 3 about here]

Finally, we have also examined the average total cash flow for each firm. 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 firms during the sample period. The next subsection investigates the possible origins of these hedging gains.

B. Speculative cash flows and risk premia

The analysis in Section III 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 risk premia. 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 the time series variation of the risk premium, we analyze the variable speculative cash flow, i.e. the difference between a firm's total derivatives cash flow and its fixed hedge cash flow. We also analyze the fixed hedge cash flow for evidence of risk premia. To calculate the fixed hedge cash flow we use a firm's actual derivatives portfolio, except that we recalculate the number of contracts outstanding for each instrument using

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

where N_{actual} equals the number of contracts outstanding for each contract type. The fixed hedge ratio equals a firm's average hedge ratio over the sample period, and N_{fixed} is the corresponding number of contracts. We calculate the fixed hedge cash flow using exactly the same procedure as the one we used for the calculation of total cash flow, described in Appendix C.

Table V reports descriptive statistics of the fixed hedge and variable speculative cash flows. While the cash flows from variable speculation are not significantly different from zero, the fixed hedge cash flows are highly significant and positive. In fact, the fixed hedge cash flows are not significantly different from firms' total derivatives cash flows reported in Table IV.

[Place Table V about here]

To check the robustness of these results we repeat the previous analysis for three sub periods. Gold prices were generally falling during two of the sub periods and rising during the third. The results are reported in Table VI. Firms' total derivatives cash flows were significantly positive in all three sub periods, although they were clearly higher when prices were falling. The fixed hedge cash flows were significantly positive when gold prices were falling. When prices were rising, the fixed hedge cash flows were also significantly positive, although not when measured per unit of gold hedged or produced. Most interestingly, though, in none of the three sub periods were the variable speculative cash flows significantly different from zero. That is, gold mining firms on average were not able to improve upon their total derivatives cash flows by changing their hedge ratios to time the variation in the risk premium.

[Place Table VI about here]

The large positive returns from maintaining a fixed 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. Table VII reports the risk premia, defined by [F(t,T) – S(T)], for five different maturities in the gold market. All risk premia are significantly positive.

[Place Table VII about here]

For example, if a speculator had shorted one-year forwards every month (or every quarter) between 1989 and 1999, and had held each contract until maturity, then the speculator would have earned $25 per ounce of gold on average. Using 2-year contracts a speculator could have earned $55 per ounce of gold on average. In light of these gains, the average cash flow of $6/ounce that gold mining companies generate appears small.

Figure 4 shows that the risk premium in the gold market was significantly positive for most of the time between 1989 and 1999. Only one- and two-year contracts entered into in 1992 and 1993 would have turned out to be unprofitable. This is not surprising given that the risk premia for one- and two-year contracts reversed signs during this period.

[Place Figure 4 about here]

Thus, gold producers that sold gold in the forward market could have benefited handsomely from a persistent positive risk premium in the gold market. While continually selling short is a risky strategy for speculators, the same is not true for gold mining companies. This is due to their inherently long position in gold, stemming from their gold reserves. Thus, gold mining companies have a comparative advantage in benefiting from a positive risk premium in the gold market relative to pure speculators.

We now return to examining the gains from variable speculation. Tables V and VI show that variable speculative cash flows across the industry were not significantly different from zero on average. Thus, deviating from a fixed hedge ratio strategy, i.e. changing the size of a hedge due to managers' market views, does not create value on average. However, the standard deviation of the variable speculative cash flows is relatively large. There are a significant number of firms that gain through time varying speculation but an equal number of firms that lose. About 50% of firms gain or lose more that $5/oz of gold sold forward. Figure 5 shows that the distribution of the variable speculative cash flows is symmetric and centered at zero.

[Place Figure 5 about here]

Are there systematic differences between winners and losers? We investigate whether cross-sectional differences in firms' variable speculative cash flows can be explained by how firms use derivatives. For example, does the extent of a firm's derivatives use explain its success in generating positive variable speculative cash flows? To answer this question we regress the variable speculative cash flows on the volatilities of firms' hedge ratios (which proxy for the intensity of firms' variable speculative activity). However, as the results in Table VIII reveal, we find no significant relation between variable speculative cash flows and hedge ratio volatility.

[Place Table VIII about here]

We have also checked whether firms' choice of hedging instruments (forwards, call options, put options, collars) is correlated with the variable speculative cash flows, but found no statistically significant relationship.

Is there persistence in who wins and who loses? Specifically, we investigate whether obtaining a positive (negative) variable speculative cash flow in one quarter increases the likelihood that a firm will generate a positive (negative) variable speculative cash flow in the next quarter. Table IX shows the probabilities of generating a positive and negative variable speculative cash flow for each quarter, given that the variable speculative 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 variable speculative cash flow in one quarter increases the likelihood that a firm will experience a negative variable speculative cash flow in the following quarter, and vice versa.

[Place Table IX about here]

As a final test we analyze the time series properties of the variable speculative cash flows. Figure 6 graphs the mean and median variable speculative cash flows over time. A one-sample runs test of randomness[13] revealed that the sequence of the average variable speculative cash flow cannot be distinguished from a random draw. Thus we conclude that variable speculative cash flows are random.

It is interesting to note that the volatility in the mean and median variable speculative cash flows is time dependent. From 1994 to 1997, the volatility is significantly lower than during the rest of the sample period. Interestingly, total derivatives cash flows were at their lowest level during the same 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.

[Place Figure 6 about here]

In summary, we have found no evidence based on our analysis of variable speculative cash flows that firms are systematically successful at speculating on changes in the risk premium. The average variable speculative cash flows across firms are not significantly different from zero. While there are winners and losers at each point in time, there are no significant cross-sectional differences between winners and losers, and that there are no persistent winners and losers. In fact, the average speculative cash flow cannot be distinguished from a random draw. These results indicate that although mining firms seem to speculate by changing their hedge ratios over time, this does not translate into a significant increase in their derivatives cash flows that we could attribute to the successful timing of changes in risk premia.

[13] See Siegel and Castellan (1988).

V. Conclusions

Can managers create value for shareholders by incorporating their market views into their hedging programs? Even in the absence of speculative motives, can derivatives transactions by themselves have a positive NPV? While our evidence does not permit us to conclusively affirm or reject the first question, our answer to the second question is an unqualified "yes." Regardless of the capabilities of managers, the latter finding contradicts the conventional wisdom in the risk management literature and has potentially important implications for future research. There is no *ex ante* reason to believe that such opportunities 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.

Even if the managers of our sample firms did not deliberately speculate on the systematic risk premia in the gold market that persisted throughout the 10-year period of our study, it is evident that they would have added considerable value to their firms by doing so. While managers who use derivatives for pure speculation are likely to be found in violation of their mandate, the issue becomes less clear when speculative components are embedded within a hedging program. In this case, hedging and speculation are no longer mutually exclusive activities. For example, a firm may determine that hedging 50% of its output is optimal based on considerations such as minimizing taxes or bankruptcy costs. However, it may translate this determination into a policy of hedging 30-70% of its output, with the exact size of the hedge at any point in time being determined by speculative considerations. The intertwining of hedging and speculation raises some interesting questions that we also leave for future research.

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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.[14] 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.

A. 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:

[14] 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.

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

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). 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.

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

B. 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 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.[15] 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.

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

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

C. 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.[16]

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

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.

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

D. 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

[16] 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.

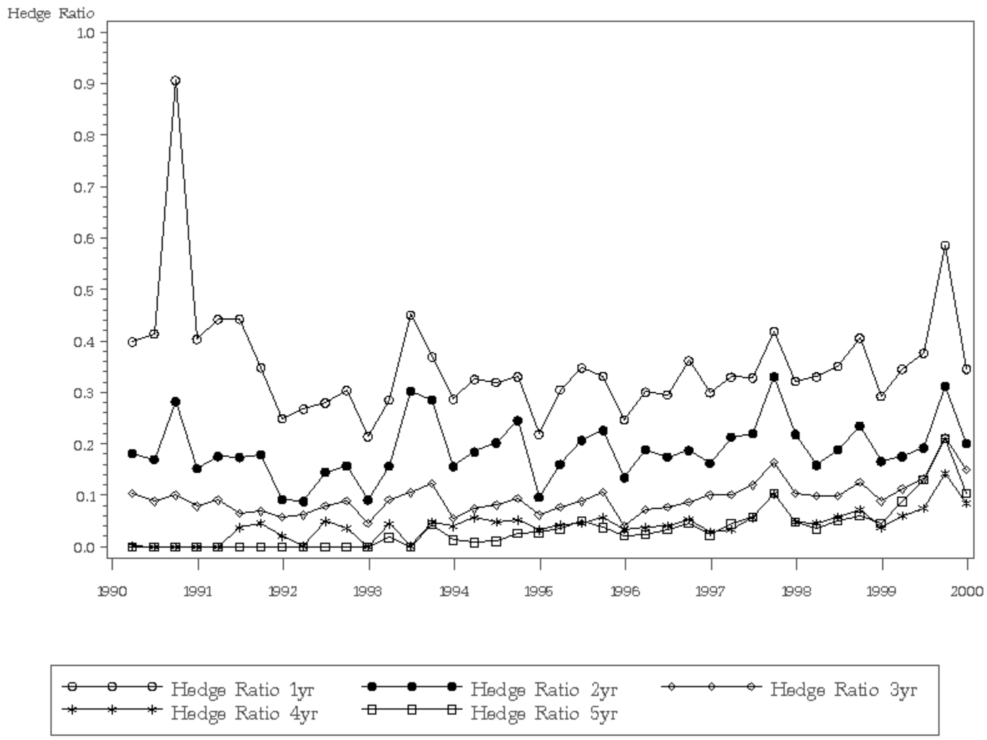
missing data, the term structure of gold lease rates is assumed to be flat. Interest rates, the gold lease rate, and the gold price volatility are calculated as monthly rates assuming continuous compounding. We use two methods to infer forward gold prices. First we calculate them using the equation:

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

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.

Figure 1
Hedge Ratios in the Gold Mining Industry during 1989-1999

Mean Hedge Ratios (All Firms)



Median Hedge Ratios (Only Firms that Use Derivatives)

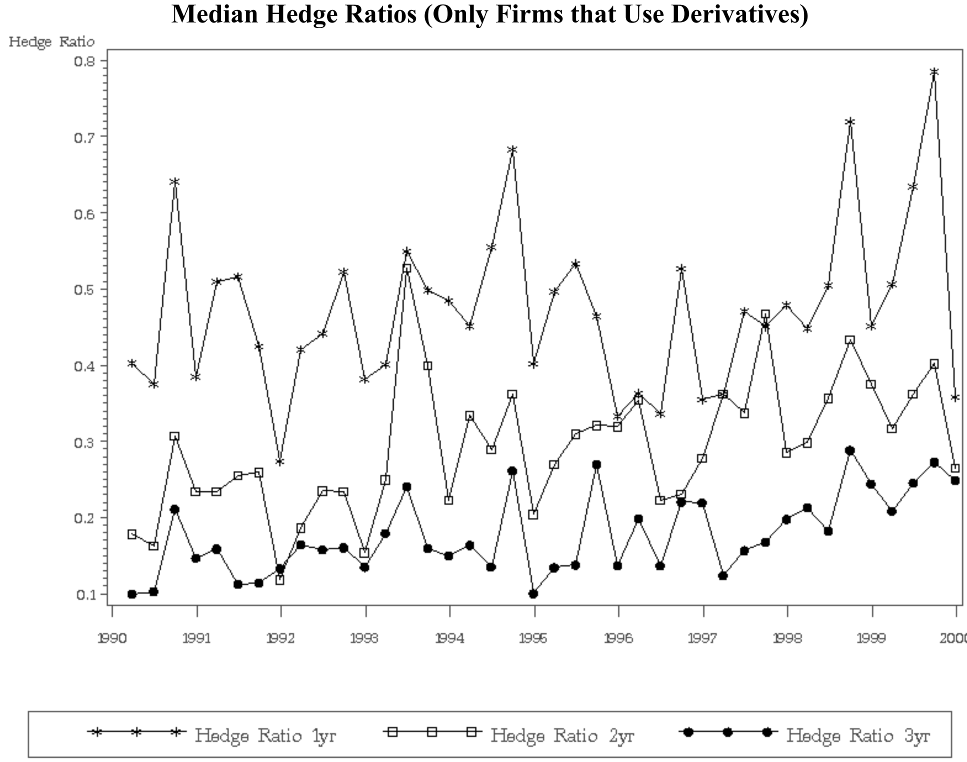


Figure 2
Distribution of Total Derivatives Cash Flows ($ per ounce of gold hedged)

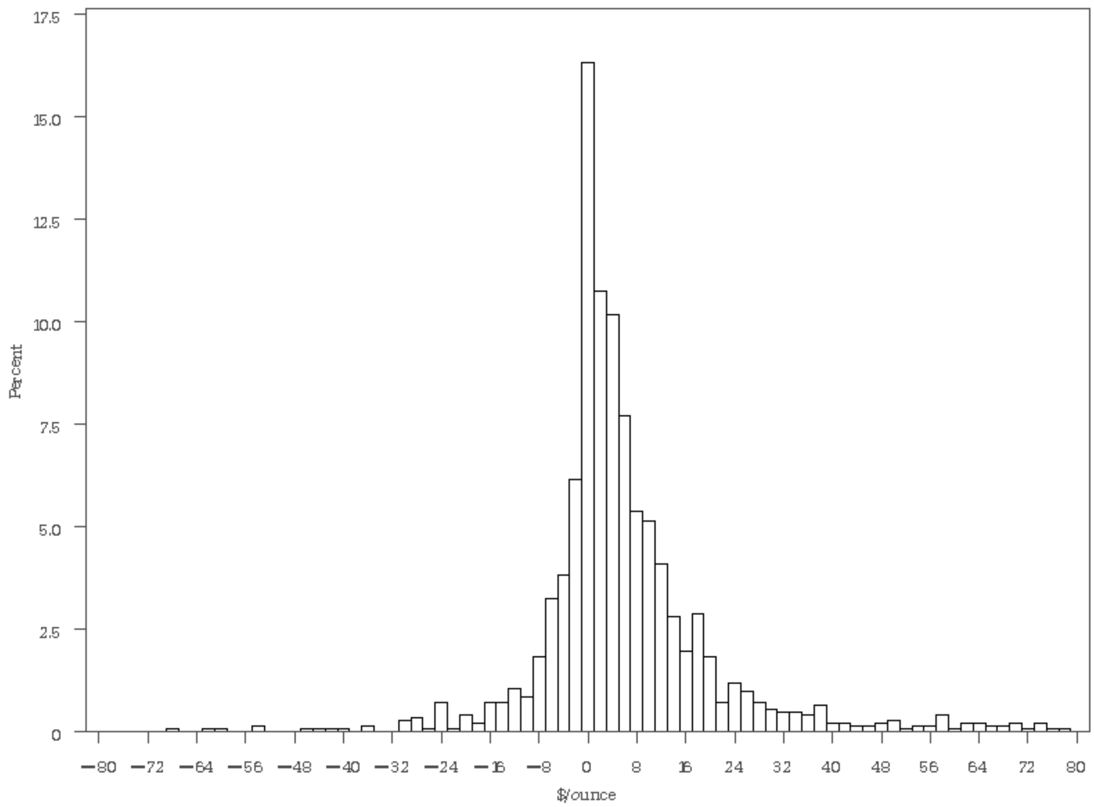
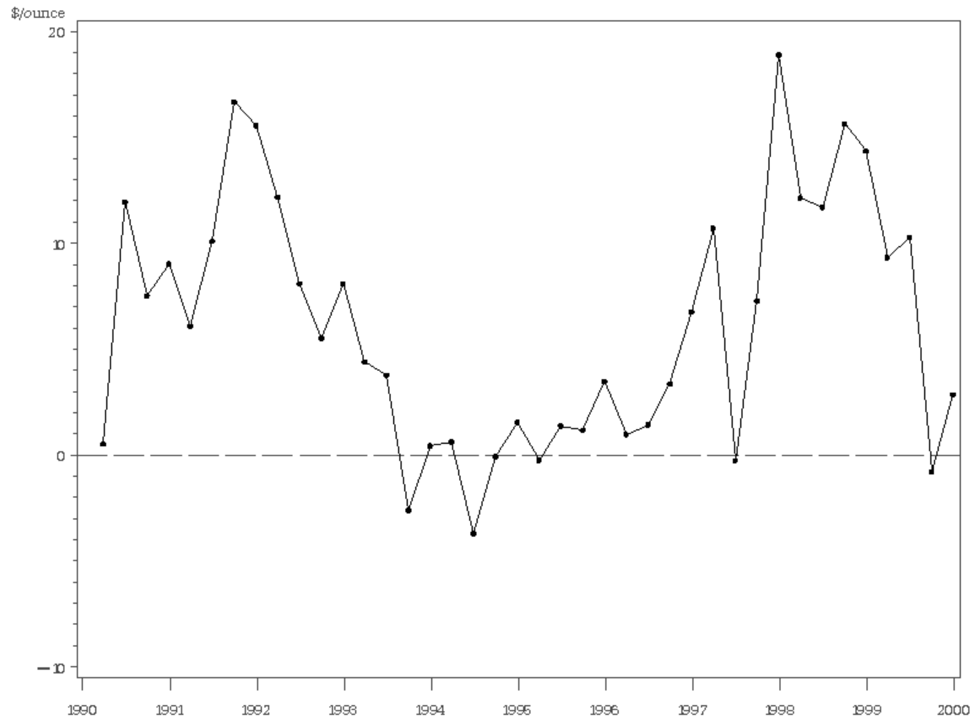


Figure 3
Mean and Median of Total Derivatives Cash Flows during 1989-1999

Total Derivatives Cash Flows (Mean) ($ per ounce of gold hedged)



Total Derivatives Cash Flows (Median) ($ per ounce of gold hedged)

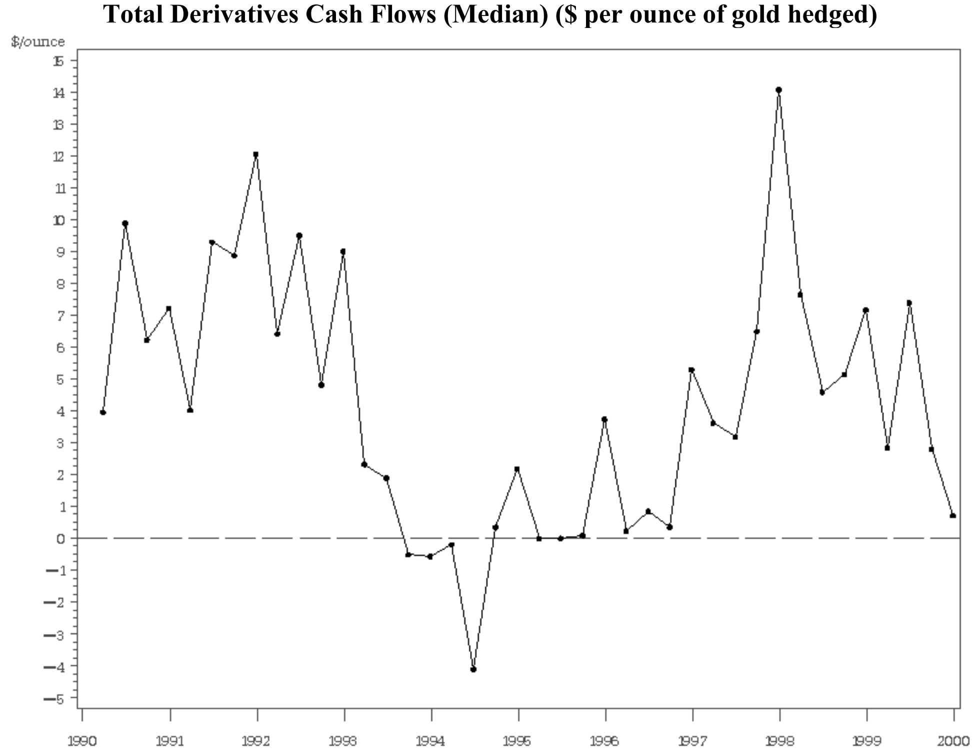


Figure 4
Risk Premia in Gold Forward Prices during 1989-1999

Time Series Plot of F(t,T) – S(T)

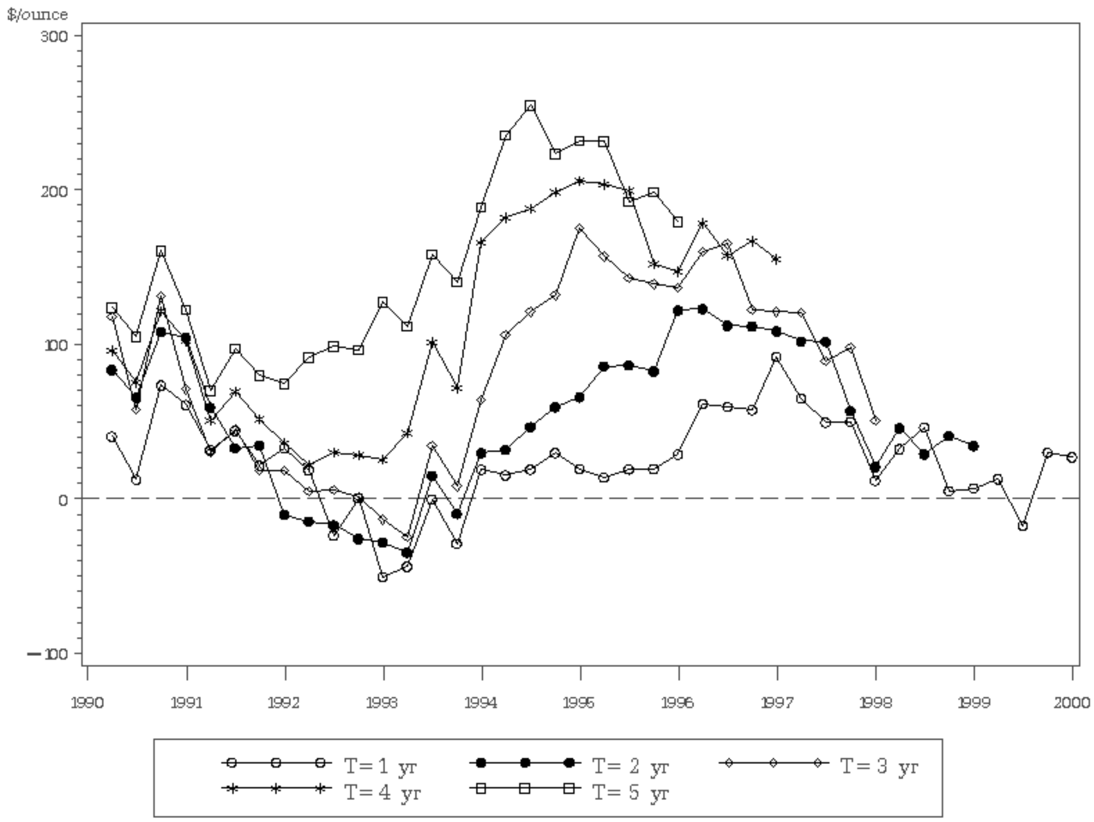


Figure 5
Distribution of Variable Speculative Cash Flows ($ per ounce of gold hedged)

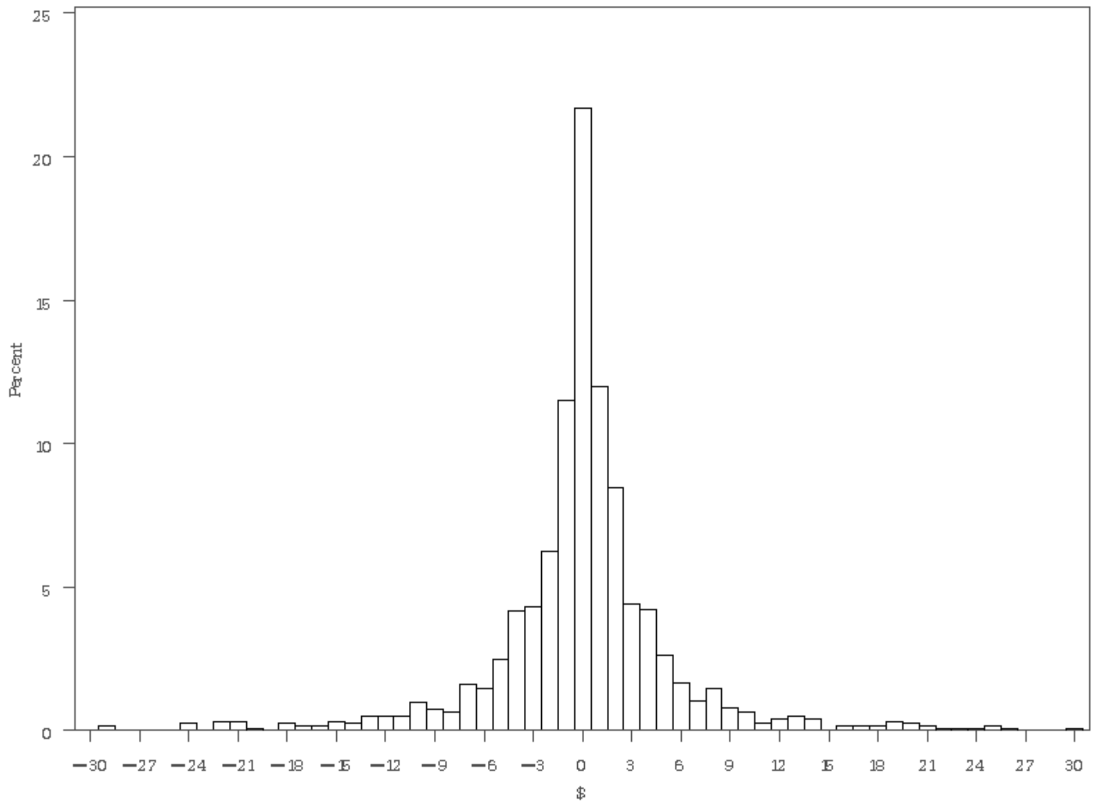


Figure 6
Time Series of Variable Speculative Cash Flows ($ per ounce of gold hedged)

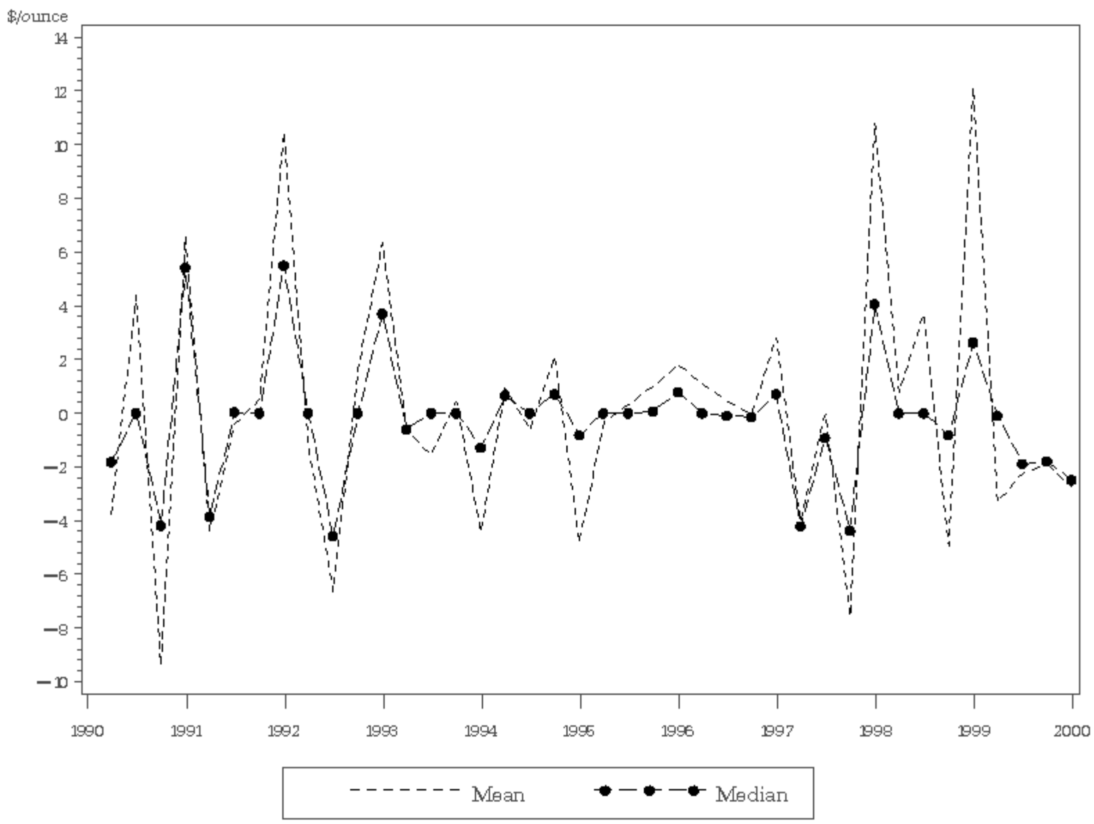


Table I
Descriptive Statistics of Sample Firms

This table provides firm specific information on gold mining companies for the fiscal years 1989 - 1998. The market value of assets equals the book value of assets minus book value of common stock plus market value of equity. Furthermore the market value is adjusted by the producer price index for commodities. The value of gold reserves is the Hotelling value of proven & probable gold reserves (in 1998 dollars), calculated by size of reserve × (gold spot price – cash cost). The profit margin is the relative difference between the gold spot price and the per-unit extraction costs of gold. The Herfindahl index (asset segments) is defined by $\sum_{i=1}^{N}\left(\frac{q_i}{q}\right)^2$, where q_i is the book value of assets of industry segment i, and q is the total book value of all reported industry segment assets (non-reported assets such as financial assets are ignored). N is the total number of industry segments. An analog formula is used for the construction of the Herfindahl index (metals production). Leverage is defined as the book value of total liabilities divided by the market value of assets. The market value of assets equals book value of assets minus book value of common stock plus market value of equity. The debt-equity ratio equals the book value of long-term debt divided by the book values of preferred stock and common equity. If the book value of equity is negative, a missing value is assigned. Outliers (top 1% of extreme values) have been removed from the sample.

	Mean	*Median*	*Std. Dev.*	*Min*	*Max*	*Obs.*
Market value of assets (in 1998 million $)	1079	301	1837	5	11529	431
Value of gold reserves (in 1998 million $)	423	60	1226	0	14407	431
Market-to-book ratio of assets	1.83	1.59	0.87	0.42	4.93	418
Profit margin	0.30	0.31	0.19	-0.70	0.91	397
Herfindahl index (asset segments)	0.94	1	0.17	0.23	1	481
Herfindahl index (metals production)	0.86	1	0.21	0.28	1	420
Quick ratio	2.86	1.67	3.84	0.01	29.7	430
Leverage	0.15	0.09	0.18	0	0.95	430
Credit rating dummy	0.18	0	0.39	0	1	481
Dividend dummy	0.47	0	0.50	0	1	455
Dividend payout ratio	0.18	0	0.38	0	2.80	380

Table II

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 and the results are presented both for the entire sample of firms as well as only for the firms that use derivatives. Hedge ratio volatilities are calculated for each firm using derivatives based on quarterly observations, and the means and medians calculated cross-sectionally across this sub-sample of firms. Volatilities were only calculated if there were at least 12 quarterly hedge ratio observations.

Hedge Ratios

All Firms				Only Firms that Use Derivatives			
Hedge horizon (years)	Mean	Median	No. of observations	Hedge horizon (years)	Mean	Median	No. of observations
1	0.35	0.23	1997	1	0.54	0.46	1294
2	0.19	0.03	1999	2	0.36	0.28	1029
3	0.09	0.10	2017	3	0.25	0.17	744
4	0.04	0.00	2055	4	0.20	0.14	439
5	0.03	0.00	2074	5	0.28	0.18	261

Hedge Ratio Volatilities (standard deviation)

Hedge horizon (years)	Mean	Median	No. of observations
1	0.28	0.25	60
2	0.19	0.17	61
3	0.14	0.12	48
4	0.11	0.09	37
5	0.15	0.11	28

Table III

Hedge Ratio Regressions

This table presents OLS regression results of the 5 hedge ratios on gold prices. We have estimated the following regressions: (a) change in hedge ratio (x) [ΔHR(x)] = a +b*change in gold price; and (b) hedge ratio(x) = a +b*gold price, where x = 1, 2, 3, 4, 5 refers to the maturity in years.

	Δ1-year hedge ratio	Δ2-year hedge ratio	Δ3-year hedge ratio	Δ4-year hedge ratio	Δ5-year hedge ratio
Intercept	0.0274 (2.44)**	0.0345 (4.61)***	0.0268 (4.37)***	0.0398 (3.97)***	0.0619 (3.01)***
ΔGold Price	0.0034 (5.88)***	0.0018 (4.84)***	0.00045 (1.45)	0.0011 (1.70)*	0.0014 (1.18)
Adj. R^2	0.0277	0.0236	0.0016	0.0046	0.0016
F value (p-value)	34.52 (0.000)	23.43 (0.000)	2.10 (0.1475)	2.90 (0.0892)	1.40 (0.2375)
# obs.	1178	929	681	411	245

	1-year hedge ratio	2-year hedge ratio	3-year hedge ratio	4-year hedge ratio	5-year hedge ratio
Intercept	0.5212 (4.56)***	0.5968 (6.61)***	0.5771 (7.03)***	0.2685 (3.32)***	0.8245 (5.59)***
Gold Price	0.000045 (0.14)	-0.000657 (-2.59)***	-0.00093 (-4.00)***	-0.0002 (-0.87)	-0.0016 (-3.73)***
Adj. R^2	-0.0008	0.0055	0.0198	-0.0005	0.0474
F value (p-value)	0.02 (0.8905)	6.69 (0.0099)	16.01 (0.000)	0.76 (0.3833)	13.95 (0.0002)
# obs.	1293	1028	743	438	260

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

Table IV

Summary Statistics and Significance Tests for 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. Values significant at the 5% level or higher are displayed in bold face.

	Units	Mean	Median	Standard deviation	No of observations	Total (sum over all observations)
Total derivatives cash flows	$ (million)	**2.73** (0.000)	**0.26** (0.000)	18.75	1428	3,904
	$/hedged ounces	**6.35** (0.000)	**3.42** (0.000)	17.95	1428	na
	$/production ounces	**3.36** (0.000)	**1.19** (0.000)	13.61	1275	na

Table V

Summary Statistics and Significance Tests for Fixed Hedge and Variable Speculative Cash Flows

This table presents standard summary statistics of the quarterly cash flows associated with a fixed hedge ratio strategy and of the quarterly variable speculative cash flows. The variable speculative cash flow is defined as the difference between the total derivatives cash flow and the fixed hedge cash flows. 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. Values significant at the 5% level or higher are displayed in bold face.

	Units	Mean	Median	Standard deviation	No of observations	Total (sum over all observations)
Fixed hedge cash flows	$ (million)	**2.65** (0.000)	**0.25** (0.000)	16.34	1428	3,788
	$/hedged ounces	**6.18** (0.000)	**3.72** (0.000)	19.60	1428	na
	$/production ounces	**3.29** (0.000)	**1.10** (0.000)	13.89	1275	na
Variable speculative cash flows	$ (million)	0.081 (0.8422)	0.000 (0.4371)	15.39	1428	115
	$/hedged ounces	0.170 (0.6288)	0.000 (0.3196)	13.27	1428	na
	$/production ounces	0.075 (0.8215)	0.019 (0.4112)	11.86	1275	na

Table VI

Total, Fixed Hedge and Variable Speculative Cash Flows (sub-period analysis)

This table presents sample medians of the total, fixed hedge and variable speculative cash flows for three sub-periods. Figures are based on the pooled sample. Figures in parentheses denote p-values. We use the Wilcoxon rank-sum test to test whether the medians are zero. Values significant at the 5% level or higher are displayed in bold face.

		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	$ (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)
Fixed hedge cash flows	$ (million)	**0.374** (0.000)	**0.014** (0.017)	**0.454** (0.000)
	$/hedged ounces	**7.30** (0.000)	0.25 (0.171)	**5.49** (0.000)
	$/production ounces	**2.18** (0.000)	0.11 (0.150)	**1.49** (0.000)
Variable speculative cash flows	$ (million)	0.010 (0.779)	0.000 (0.191)	0.000 (0.969)
	$/hedged ounces	0.00 (0.940)	0.00 (0.421)	-0.13 (0.054)
	$/production ounces	0.13 (0.870)	0.02 (0.236)	-0.001 (0.818)

Table VII

Risk Premia in Forward Market for Gold

This table presents results of a basic test for statistically significant risk premia in gold prices. The risk premium is measured by the differential between the time T futures price measured at time t, F(t,T) and the spot price realized at time T, S(T). We present results for (T-t) = 1,2,3,4,5 years, for both monthly and quarterly observations. We report results from a t-test against a null of F(t,T) – S(T) = 0.

Hedge horizon (T-t) in years	Monthly observations		Quarterly observations	
	# obs.	Mean	# obs.	Mean
1	113	25.65 (8.91)***	38	24.64 (4.88)***
2	101	55.97 (11.63)***	34	55.19 (6.57)***
3	89	84.11 (12.67)***	30	83.21 (7.30)***
4	77	108.54 (15.23)***	26	107.74 (8.64)***
5	65	140.00 (19.94)***	22	138.63 (11.59)***

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

Table VIII

Regression of Variable Speculative Cash Flows on Volatility of Hedge Ratios

This table presents OLS regression results of the variable speculative cash flows on hedge ratio volatilities. We estimate the following 5 regressions: variable speculative cash flow = = a + b×hedge ratio volatility (x), where x = 1,2,3,4,5 refers to the maturity of the hedge in years. Figures in parentheses are t-statistics. Similar results are obtained if one observation per firm is used instead of the full panel data set.

	Dependent variable: Variable speculative cash flow				
	x = 1	x = 2	x = 3	x = 4	x = 5
Intercept	0.08527 (0.11)	-0.19044 (-0.33)	-0.15359 (-0.24)	-0.22214 (-0.36)	0.68165 (0.96)
Hedge ratio volatility (x)	0.79322 (0.33)	2.42840 (0.96)	2.80925 (0.77)	3.20081 (0.76)	-2.54779 (-0.77)
Adj. R^2	-0.0008	-0.0001	-0.0004	-0.0005	-0.0006
F value (p-value)	0.11 (0.7441)	0.93 (0.3352)	0.60 (0.4402)	0.57 (0.4495)	0.59 (0.4411)
# obs.	1163	1169	1031	886	703

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

Table IX: Binomial Tests of Persistence

This table lists the probabilities that a firm's variable speculative cash flows are positive/negative in period t conditional on the firm's variable speculative 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*