Hedging, speculation, and shareholder value

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Abstract

We document that gold mining firms have consistently realized economically significant cash flow gains from their derivatives transactions. We conclude that these cash flows have increased shareholder value since there is no evidence of an offsetting adjustment in firms' systematic risk. This finding contradicts a central assumption in the risk management literature that derivatives transactions have zero net present value, and highlights an important motive for firms to use derivatives that the literature has hitherto ignored. Although we find considerable evidence of selective hedging in our sample, the cash flow gains from selective hedging appear to be small at best.

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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.

1. Introduction

The above statements are puzzling because the existing theories of corporate hedging assume that the use of derivatives does not itself increase a firm’s value. Rather, the use of derivatives is thought to add value by alleviating a variety of market imperfections through hedging. 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? First, it is possible that managers believe that they can create value for shareholders by incorporating speculative elements into their hedging programs. It is also possible that the pricing of derivatives contracts in some markets gives rise to positive derivatives cash flows. These issues have received little attention in the literature on corporate risk management, possibly due to a lack of adequate firm-specific data on derivatives usage.

We address the question of whether using derivatives is intrinsically valuable by examining a unique database that contains quarterly observations on all outstanding gold derivatives positions for a sample of 92 North American gold mining firms from 1989 to 1999.¹ This data set allows us to infer and analyze on a quarterly basis over a ten-year period the actual cash flows that stem from each firm’s derivatives transactions. We compare the actual cash flows with benchmarks to determine both whether firms make or lose money using derivatives, and what the sources of these gains or losses may be.

We find that the firms in our study generate positive cash flows that are highly significant both economically and statistically. Moreover, these positive cash flows 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 their average annual net income is only $3.5 million. The bulk of the cash flow gain appears to stem from persistent positive realized risk premia, i.e., positive spreads between contracted forward prices and realized spot prices. We find no evidence that the use of derivatives has increased the systematic risk for the firms in our sample. These findings imply that firms’ derivatives transactions translate into increases in shareholder value.

Furthermore, we find considerable excess volatility in firms’ hedge ratios over time, which is consistent with evidence provided by Dolde (1993) and Bodnar et al. (1998) that managers incorporate their market views into their hedging programs. Stulz (1996) refers to this type of speculation as “selective hedging.” However, we find that the average cash flow gains from selective hedging are small at best.

We make two major contributions to the risk management literature. First, we show that a central tenet of hedging theory, that derivatives transactions have zero net present value,

can be violated for an extended period. Second, and in contrast to our first contribution, we show that firms do not realize economically significant benefits by trying to time the market through selective hedging. The risk premia that give rise to positive derivatives cash flows can be a potentially important motive for firms to use derivatives. This possibility is not considered in the current literature on corporate risk management. Moreover, by disregarding these cash flows, one obtains an erroneous measurement of the hedging benefits that arise from the alleviation of market imperfections. For example, Allayannis and Weston (2001) show that for a sample of 720 large nonfinancial 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.

Our work is related to a recent study by Brown et al. (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 in their sample the potential economic benefit of selective hedging is quite small. However, they do not analyze the total cash flow effects of derivatives use as we do. Our work is also related to a recent study by Hentschel and Kothari (2001) who find few, if any, measurable differences in the risk exposures of firms that use derivatives and those that do not, and conclude that derivatives usage has no measurable impact on exposure or volatility. In contrast, derivatives users in our sample reduce their one-year gold price exposures by 54% on average, and earn substantial additional cash flows from their derivatives transactions. Finally, our data set and methodology enable a more precise measurement of firms’ derivatives cash flows than has been previously possible. For instance, Allayannis and Mozumdar (2000) infer annual derivatives cash flows from income statements, but their methodology works only for a small number of firms in their sample. Guay and Kothari (2003) use simulation analysis to estimate the cash flows from derivatives transactions of nonfinancial firms. In contrast, we use quarterly observations on firms’ derivatives positions to derive the actual quarterly cash flows that stem from firms’ derivatives activities. Furthermore, the time-series nature of our data set allows us to analyze the hedging behavior of each individual firm in our sample.

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. Section 3 describes our sample and the data sources. Section 4 presents our evidence on the existence of selective hedging in our sample. Section 5 discusses our findings on the cash flow and value gains from risk premia and selective hedging. Finally, Section 6 concludes.

2. Risk premia and their effects on hedging strategies

In this section of the paper we discuss how the presence of risk premia in futures prices can affect the way firms use derivatives to hedge risk. We begin by briefly reviewing the literature on risk premia. Thereafter we discuss how a firm might alter its hedging strategy in the presence of risk premia.

2.1. Risk premia in futures prices

The existing theories of corporate risk management assume that firms use derivatives purely for hedging purposes, and that the benefits of derivatives usage accrue solely from the alleviation of market imperfections such as taxes, bankruptcy costs, financing
constraints, agency costs, and undiversified stakeholders (Stulz, 1984, 1990; Smith and Stulz, 1985; Froot et al., 1993; DeMarzo and Duffie, 1995; Mello and Parsons, 2000). These theories implicitly assume that the expected return of a derivatives portfolio is zero, which would be the case if the unbiased expectations hypothesis holds. However, numerous studies document evidence to the contrary. 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 show further 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 Treasury bill yields, equity dividend yields, and the junk bond premium as instrumental variables. They attribute this forecastability to time-varying risk premia in futures prices.

Researchers attribute risk premia in futures prices to hedging pressure, systematic risk, or a combination of the two. According to the hedging pressure theory, which dates back to Keynes (1930) and Hicks (1939), hedgers pay a (risk) premium to transfer their risk to speculators, in turn causing futures prices to deviate from expected future spot prices. According to the systematic risk theory, risk premia result from undiversifiable risk in futures prices (see, for example, Dusak, 1973; Black, 1976). Stoll (1979) and Hirshleifer (1989, 1990) present models in which risk premia depend on both hedging pressure and systematic risk. While the structural determinants of risk premia in the gold market have not been systematically examined to our knowledge, Shimko and McDonald (1997) argue that the gold lending activities undertaken by central banks artificially depress the gold lease rate, and thereby cause an upward bias in forward prices. Since gold producers hedge by selling forward, Shimko and McDonald (1997) argue that central banks are indirectly subsidizing the hedging activities of gold producers.

The existence of persistent risk premia may provide firms added incentives to use derivatives because, in such a case, derivatives cash flows are expected to be nonzero. 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. 

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2See, for example, Tufano (1996), Géczy et al. (1997), Graham and Smith (1999), Brown (2001), and Graham and Rogers (2002) for empirical evidence on why firms hedge.

3Keynes (1930) called the difference between the forward price and the future spot price the “risk premium” since he viewed it as the compensation for risk that is paid by hedgers to speculators. Several authors document risk premia in various commodity and currency markets. 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. As noted by Fama and French (1987), the risk premium is different from the “basis,” 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.

4It 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.
Even firms that use derivatives for hedging purposes may decide to adjust the extent to which they hedge in the presence of risk premia. To our knowledge, these possibilities have not been explored in the corporate risk management literature.

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 time-\( t \) spot price. 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 a forward contract has zero expected value. In this case, the firm will choose a hedge ratio, \( h^{\text{fund}} \), based purely on hedging fundamentals. 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 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, the bias will also be time-variable. Thus, the volatility of a firm’s hedge ratio 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, namely, (i) a component attributable to hedging fundamentals plus any constant bias due to the constant component of the expected risk premium, and (ii) a component attributable to any time-varying component of the expected risk premium, or changes in a firm’s market views (selective hedging).

We refer to “(i)” above as the predicted hedge cash flows, and “(ii)” as the selective hedge cash flows. 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, encompassing the majority of firms in the gold mining industry. These firms are included in the Gold and Silver Hedge Outlook, a quarterly survey conducted by Ted Reeve, an analyst at Scotia McLeod, from 1989 to 1999. Firms not included in the survey tend to be small or privately held corporations.

The survey contains information on all outstanding gold derivatives positions, their size and direction, maturities, and the respective delivery prices for each instrument. The
derivatives portfolios consist of forward instruments (forwards, spot-deferred contracts, and gold loans) and options (put and call). There are a total of 2,541 firm-quarter observations of which 1,450 firm-quarters represent nonzero hedging portfolios. Tufano (1996) and Adam (2002) provide further details about this data set.

This data set, together with market data on average gold spot and futures prices, interest rates, and the gold lease rate, permits us to calculate the quarterly net cash flows associated with each derivatives transaction for each firm. A detailed description of how we perform these calculations is provided in the appendix. Daily gold spot and futures prices are obtained from Datastream. Daily Treasury constant maturity interest rates (one-month to seven-year) are from Federal Reserve Statistical Release H.15. Scotia McLeod provides the gold lease rates on a monthly basis until December 1996 and the more recent figures are from Bloomberg. We interpolate the missing interest rates linearly using two adjacent data points. Due to missing data, the term structure of gold lease rates is assumed to be flat. We infer forward gold prices by calculating them using the forward pricing formula and by using futures prices.

We obtain financial data from Compustat, or from a manual search of firms’ financial statements if a firm is not covered by Compustat. Stock market return data comes from the CRSP database. Operational data, e.g., gold production figures, production costs per ounce of gold, etc., we collect by hand from firms’ financial statements.

4. Analysis of hedge ratios

There is considerable survey evidence that managers’ market views affect their risk management decisions. In a survey of 244 Fortune 500 firms, Dolde (1993) reports that almost 90% of the firms surveyed base the size of their hedges on their market views at least occasionally. Bodnar et al. (1998) survey derivatives usage by 399 U.S. nonfinancial firms, and find that about 50% (10%) of their sample firms admit to occasionally (frequently) altering the size and/or timing of a hedge due to managers’ market views. Glaum (2002) surveys the risk management practices of the major nonfinancial firms in Germany and finds that the majority follow forecast-based, profit-oriented risk management strategies. Graham and Harvey (2001), Baker and Wurgler (2002), and Naik and Yadav (2003) discuss other situations in which market views influence corporate decision making.

There is also evidence that some degree of speculation is widespread in the gold mining industry. For example, Adam (2005) reports that eight out of 13 surveyed firms (62%) stated that their expectations about future metal prices are very important or fairly important in determining the extent to which they hedge. For three firms (23%), increasing sales revenue is the primary objective of their risk management programs. Brown et al. (2002) report that managers’ market views appear to have an impact on gold producers’ hedging strategies, which is consistent with Barrick Gold’s statement in its 2002 annual report, “We are reducing... our (hedging) program, given... our positive view of the gold price.” Anecdotal evidence suggests that at least some gold mining firms are aware of the opportunities of a positive persistent risk premium in the gold market. For example, Prime Resources Group, Inc. states in its 1997 annual report, “We view hedging as a vehicle to enhance our revenue over the long term.” Similarly, the opening quote of this paper suggests that Placer Pacific may be using derivatives to benefit from a persistent risk premium in the gold market.
It is important to note that a hedging strategy designed to benefit from risk premia is not without its own set of risks. The well-publicized derivatives-related loss at Metallgesellschaft AG (MG), documented by Culp and Miller (1995) and Mello and Parsons (1995), is a case in point. In 1992, MG’s U.S. subsidiary MG Refining and Marketing (MGRM) sold five- and 10-year delivery contracts for gasoline and other petroleum products. The resulting price exposure was hedged by purchasing a stack of one-month crude oil and gasoline futures contracts. 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 would book a roll-over gain as long as the backwardation continued to persist, reducing any cash needs to support the hedging program, e.g., for margin calls. The collapse of oil prices in September 1993 had two negative effects for MGRM. First, the plunge in prices triggered substantial margin calls. Second, the basis reversed from backwardation to contango, replacing the previous gains from the rolling strategy with losses, and aggravating the cash drain. 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 one billion dollars 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 their planned gold production. These differences make it less likely that gold mining firms will face the level of distress that MG encountered. Nonetheless, in 1999, Ashanti Goldfields and Cambior were hit by margin calls because the losses of their hedge books exceeded their lines of credit with their bankers. Both companies maintained unusually large hedge positions, and thus faced a credit squeeze similar to that of MG.

In order to quantify the extent of selective hedging in our sample, we analyze the time-series behavior of firms’ 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

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

where \(x = 1, 2, 3, 4, 5\). The portfolio delta is the weighted sum of the deltas of the individual derivatives positions.\(^5\) Table 1 provides descriptive statistics of the five hedge ratios separately for all firms in the sample (Panel A), for all firms excluding firms that do not use

\(^5\)Tufano (1996) refers to this ratio as the “delta-percentage.” Unlike in Tufano (1996), however, a potential bias 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 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.
any derivatives during a quarter (Panel B), and for firms that choose positive hedge ratios (Panel C).

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, with the one-year hedge ratio having an average volatility of 28%, while the five-year hedge ratio has an average volatility of 15% (see Panel D).

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

To determine what fraction of this volatility can be attributed to a hedging rationale, we regress all five hedge ratios on variables that the literature identifies 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. We include dummy 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. As discussed in Section 5, we use four other methodologies to verify the robustness of our predicted hedge ratios based on fundamentals.

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6See 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. As discussed in Section 5, we use four other methodologies to verify the robustness of our predicted hedge ratios based on fundamentals.
variables to control for any 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.7 The results are provided in Table 2.

Panel A of Table 2 presents the second-stage regression results of the Cragg model for the 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 B. Consistent with prior empirical studies, the extent of hedging is correlated with the market-to-book ratio, liquidity, and dividend policy. The $R^2$ estimates of the Cragg model regressions suggest that a maximum of 10%–20% of the variation in hedge ratios can be attributed to fundamentals.

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

In this section, we first examine the total cash flows that stem from firms’ derivatives transactions. Second, we analyze the correlations between the use of derivatives and a firm’s systematic risk to determine whether these derivatives transactions and the resulting

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7This approach does not exclude all possible forms of speculation. For example, it does not 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 note previously, if firms explicitly speculate on the gold risk premium, and this risk premium is of consistent sign throughout the sample period, this will also create a systematic bias in the predicted hedge ratio.
cash flows have any effect on shareholder value. Third, we investigate the origins of cash flow gains or losses, in particular, whether selective hedging has a positive impact on total cash flows.

As we discuss in Section 2, we divide each firm’s total derivatives cash flows into two components, predicted hedge cash flows, and selective hedge cash flows. In addition to using the predicted hedge ratios obtained from the Cragg model estimation to estimate predicted hedge cash flows, we use four other benchmarks based on the following predicted hedge ratios: (i) constant hedge ratios equal to the time-series average hedge ratios of an individual firm (referred to as “firm average”), (ii) constant hedge ratios equal to the industry average hedge ratios over the entire sample period (referred to as “industry average”), (iii) predicted hedge ratios based on an AR(4) model, and (iv) predicted hedge ratios based on a MA(4) model.

Table 2
Hedge ratio regressions
Panel A presents the second-stage regression results of the Cragg model. The dependent variables are the five hedge ratios. We estimate the following regressions: \( \ln(hedge \ ratio) = a + b \times x + e \). 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 yield the inverse Mills ratio, a necessary regressor for the second stage. Figures in parentheses denote \( t \)-statistics. In Panel B, the predicted hedge ratios are also estimated after removing outliers (top 1% of observations). Since the two sets of predicted values are very similar, we conclude that outliers do not affect the regressions in a significant way.

<table>
<thead>
<tr>
<th></th>
<th>1-year Hedge ratio</th>
<th>2-year Hedge ratio</th>
<th>3-year Hedge ratio</th>
<th>4-year Hedge ratio</th>
<th>5-year Hedge ratio</th>
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<tr>
<td>Log (firm size)</td>
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<td>0.684***</td>
<td>0.631</td>
<td>−0.137</td>
<td>1.140</td>
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<tr>
<td></td>
<td>(3.93)</td>
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<td>(1.93)</td>
<td>(1.17)</td>
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<td>Market-to-book</td>
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<td>−0.460**</td>
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<td></td>
<td>(−2.99)</td>
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<td>(−1.46)</td>
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<td>Leverage</td>
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<td></td>
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<td></td>
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<td>(−3.18)</td>
<td>(−1.92)</td>
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<tr>
<td>Inverse</td>
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<td>1.847</td>
<td>−1.421</td>
<td>3.696</td>
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<td>mills ratio</td>
<td>(2.24)</td>
<td>(1.67)</td>
<td>(1.38)</td>
<td>(−0.55)</td>
<td>(0.85)</td>
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<td>0.1534</td>
<td>0.1076</td>
<td>0.1488</td>
<td>0.1855</td>
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<td>( F )-value</td>
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<td>7.39</td>
<td>3.86</td>
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<td>3.05</td>
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<td>( N )</td>
<td>527</td>
<td>419</td>
<td>331</td>
<td>219</td>
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Panel B: descriptive statistics of predicted hedge ratios

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<th></th>
<th>Mean</th>
<th>Median</th>
<th>Std. deviation</th>
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<tr>
<td>1-year Hedge ratio</td>
<td>0.38</td>
<td>0.29</td>
<td>0.21</td>
</tr>
<tr>
<td>2-year Hedge ratio</td>
<td>0.34</td>
<td>0.26</td>
<td>0.19</td>
</tr>
<tr>
<td>3-year Hedge ratio</td>
<td>0.16</td>
<td>0.13</td>
<td>0.08</td>
</tr>
<tr>
<td>4-year Hedge ratio</td>
<td>0.16</td>
<td>0.13</td>
<td>0.08</td>
</tr>
<tr>
<td>5-year Hedge ratio</td>
<td>0.20</td>
<td>0.19</td>
<td>0.10</td>
</tr>
<tr>
<td>( N )</td>
<td>527</td>
<td>419</td>
<td>331</td>
</tr>
</tbody>
</table>

*** and ** indicate significance at the 1% and 5% levels, respectively.
To obtain the predicted hedge ratios under the AR(4) model, we estimate
\[ h_t = a + b \times h_{t-1} + c \times h_{t-2} + d \times h_{t-3} + g \times h_{t-4} + e \]  
(3)
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
\[ \text{predicted } h_{i,t} = a + b \times h_{i,t-1} + c \times h_{i,t-2} + d \times h_{i,t-3} + g \times h_{i,t-4}. \]  
(4)As in the Cragg model estimation, if the actual hedge ratio is zero, then the predicted hedge ratio is set to zero.

Under the MA (4) model the predicted hedge ratios for each firm \( i \) are given by
\[ \text{predicted } h_{i,t} = \frac{1}{4} [h_{i,t-1} + h_{i,t-2} + h_{i,t-3} + h_{i,t-4}]. \]  
(5)
In this case the predicted hedge ratio is the moving average of the past four hedge ratio realizations.

5.1. Total derivatives cash flows

As noted in Section 2, if average realized risk premia are zero and firms do not engage in selective hedging, then the average total derivatives cash flow should also equal zero over a very long time horizon. Table 3 reports descriptive statistics of the total cash flow associated with derivatives usage over our sample period. During the 1989–1999 sample period, those gold mining firms that hedge their future gold production earn an average positive derivatives cash flow of $2.73 million per quarter, resulting in a mean (median) increase in their revenues from gold mining operations of about 10% (2.5%). These gains are substantial given that their average quarterly net profit is only $0.87 million. The aggregate hedging benefit across all firms in our sample exceeds $3.9 billion. On a per ounce basis, firms that hedge gain 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 subperiods during which gold prices were falling and a third subperiod during which they were rising. Total derivatives cash flows are significantly positive in all three subperiods. However, they are substantially higher when prices are falling, indicating (not surprisingly) that realized risk premia are significantly higher when spot prices are declining. Similar results obtain when we analyze the total cash flows for each derivatives type separately.

Fig. 2 plots the total derivatives cash flows (industry mean and median) over time. The graph shows that firms generate 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 coincides with the period during which gold prices were generally rising. This result comes as a surprise to us, as we had expected to find substantial losses for hedgers during times of rising gold prices.

Finally, we also examine the average total derivatives cash flow for each firm separately. Out of a total of 92 firms, only seven produce negative average total derivatives cash flows. These results show that hedging has been tremendously profitable for most gold mining firms during the sample period.
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.


<table>
<thead>
<tr>
<th>Total derivatives cash flows: units</th>
<th>Mean</th>
<th>Median</th>
<th>Std. deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ (Million)</td>
<td>2.73*** (0.000)</td>
<td>0.26*** (0.000)</td>
<td>18.75</td>
<td>1428</td>
</tr>
<tr>
<td>$/Hedged ounces</td>
<td>6.35*** (0.000)</td>
<td>3.42*** (0.000)</td>
<td>17.95</td>
<td>1428</td>
</tr>
<tr>
<td>$/Production ounces</td>
<td>3.36*** (0.000)</td>
<td>1.19*** (0.000)</td>
<td>13.61</td>
<td>1275</td>
</tr>
</tbody>
</table>

Panel B: subperiod analysis

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$ (Million)</td>
<td>0.468*** (0.000)</td>
<td>0.001*** (0.000)</td>
<td>0.489*** (0.000)</td>
</tr>
<tr>
<td>$/Hedged ounces</td>
<td>7.10*** (0.000)</td>
<td>0.01** (0.020)</td>
<td>4.06*** (0.000)</td>
</tr>
<tr>
<td>$/Production ounces</td>
<td>2.30*** (0.000)</td>
<td>0.09*** (0.008)</td>
<td>1.63*** (0.000)</td>
</tr>
</tbody>
</table>

*** and ** indicate significance at the 1% and 5% levels, respectively.

Fig. 2. Total derivatives cash flows. This figure shows the industry mean and medians of the total cash flows (in US$ per ounce of gold hedged) of all gold derivatives transactions of firms in the gold mining industry between Jan. 1990 and Jan. 2000.

5.2. Total derivatives cash flows 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 discussed above, 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 detect are offset by an increase in the firm’s discount rate, resulting in no net increase in shareholder value. In this section we 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,

\[ R_i = \alpha + \beta R_m + \epsilon, \]  

(6)

where \( R_i \) and \( R_m \) are the returns on the firm’s stock and the market, respectively. As in Tufano (1998), we also estimate a market model that includes the return on gold, i.e.,

\[ R_i = \alpha + \beta R_m + \gamma R_{Gold} + \epsilon, \]  

but find no significant effect on our beta estimates. We also use weekly data instead of daily data, but again find no significant impact on the beta estimates. We use the CRSP NYSE/AMEX/Nasdaq composite value-weighted index as the market portfolio for companies listed in the U.S. and the Canadian Financial Markets Research Center (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 subsample 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 stock then we would expect a positive correlation between firms’ beta estimates and the extent to which they hedge.

As the results in Panel A of Table 4 reveal, we find no evidence that hedging increases stock market betas for our sample of firms. All hedge ratios are uncorrelated with firms’ stock betas. The results are robust to adding control variables, as shown in Panel B, or to repeating the analysis without 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. Our finding that market betas do not increase due to hedging suggests that the previously documented cash flow gains from hedging translate into value gains for shareholders. For U.S. companies we also specify a Fama–French three-factor model and examine the impact of hedging on all three factors. We find no statistically significant relation between any of the three factor sensitivities and the extent of hedging.

5.3. Selective hedge cash flows and risk premia

In this section we analyze the origins of the cash flow gains documented in Section 5.1. To determine whether a firm is 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. To calculate the predicted hedge cash flow we use a firm’s actual derivatives portfolio, recalculating the number of contracts outstanding for each instrument according to

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

(7)
where \( N_{\text{actual}} \) 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 at the beginning of Section 5, and \( N_{\text{predicted}} \) is the corresponding number of contracts. We calculate the predicted hedge cash flow using exactly the same procedure as the one we use for the calculation of total derivatives cash flow, as described in the appendix.

Table 4
Impact of hedging on firms’ stock market betas

The dependent variable in all regressions is a firm’s annual stock market beta, estimated from a standard market model, \( R_i = \alpha + \beta R_m + \epsilon \), 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. The average hedge ratio is the arithmetic average of all available \( x \)-year hedge ratios per firm. 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 A: dependent variable: firms’ stock market beta

<table>
<thead>
<tr>
<th>x-year Hedge ratio</th>
<th>2-year Hedge ratio</th>
<th>3-year Hedge ratio</th>
<th>4-year Hedge ratio</th>
<th>5-year Hedge ratio</th>
<th>Average Hedge ratio</th>
<th>( N )</th>
<th>( R^2 ) (Within)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>0.054 (0.31)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>309</td>
<td>0.000</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td>−0.129 (−0.64)</td>
<td></td>
<td></td>
<td></td>
<td>316</td>
<td>0.002</td>
</tr>
<tr>
<td>III</td>
<td>−0.509 (−1.90)</td>
<td></td>
<td>0.190 (0.43)</td>
<td></td>
<td></td>
<td>318</td>
<td>0.001</td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td></td>
<td>0.232 (0.69)</td>
<td></td>
<td></td>
<td>319</td>
<td>0.002</td>
</tr>
<tr>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td>−0.162 (−0.45)</td>
<td></td>
<td>306</td>
<td>0.001</td>
</tr>
<tr>
<td>VI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel B: control regressions

<table>
<thead>
<tr>
<th>x</th>
<th>x-year Hedge ratio</th>
<th>Log (firm size)</th>
<th>Leverage</th>
<th>Assets diversification</th>
<th>Production diversification</th>
<th>( N )</th>
<th>( R^2 ) (Within)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.117 (0.61)</td>
<td>0.171 (1.51)</td>
<td>1.208** (3.32)</td>
<td>−0.256 (−0.27)</td>
<td>0.411 (0.72)</td>
<td>216</td>
<td>0.097</td>
</tr>
<tr>
<td>2</td>
<td>−0.282 (−1.34)</td>
<td>0.164 (1.44)</td>
<td>1.624** (4.63)</td>
<td>−0.294 (−0.31)</td>
<td>0.523 (0.97)</td>
<td>221</td>
<td>0.144</td>
</tr>
<tr>
<td>3</td>
<td>−0.031 (−0.10)</td>
<td>0.151 (1.30)</td>
<td>1.570** (4.32)</td>
<td>−0.398 (−0.42)</td>
<td>0.466 (0.86)</td>
<td>220</td>
<td>0.135</td>
</tr>
<tr>
<td>4</td>
<td>0.396 (0.88)</td>
<td>0.143 (1.24)</td>
<td>1.545** (4.42)</td>
<td>−0.426 (−0.45)</td>
<td>0.468 (0.87)</td>
<td>220</td>
<td>0.139</td>
</tr>
<tr>
<td>5</td>
<td>0.576 (1.08)</td>
<td>0.085 (0.58)</td>
<td>0.970** (2.23)</td>
<td>1.963 (1.70)</td>
<td>0.427 (0.63)</td>
<td>221</td>
<td>0.065</td>
</tr>
<tr>
<td>Avg.</td>
<td>−0.057 (−0.15)</td>
<td>0.153 (1.42)</td>
<td>1.147*** (3.44)</td>
<td>−0.300 (−0.33)</td>
<td>0.526 (0.98)</td>
<td>223</td>
<td>0.096</td>
</tr>
</tbody>
</table>

*** and ** indicate significance at the 1% and 5% levels, respectively.
Table 5 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 1% level), similar to the firms’ total derivatives cash flows reported in Table 3. The selective hedge cash flows, measured on a dollars per ounce of gold hedged basis, are generally zero, except when we use the predicted hedge ratios from the Cragg model or 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. We repeat our analysis by computing hedge cash flows in dollars and dollars per production ounces. The results are essentially the same and we therefore do not report them here. These findings imply that gains from selective hedging are small at best.

To verify the robustness of our results further, we repeat the previous analysis for the three subperiods. Gold prices were generally falling during the first and third subperiods and rising during the middle subperiod. The results are reported in Table 6. Using all five methodologies, firms’ predicted hedge ratio cash flows are significantly positive at the 1% level when prices were falling. When prices were rising, the predicted hedge ratio cash flows are significantly positive only under the AR(4) model. As noted previously, it is surprising that firms do not realize significant losses when gold prices are rising. The selective hedge cash flows are again close to zero, although some of the values

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Mean</th>
<th>Median</th>
<th>Std. deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: summary statistics of predicted hedge ratio benchmark cash flows ($/hedged ounces)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cragg model</td>
<td>4.88*** (0.000)</td>
<td>1.41*** (0.000)</td>
<td>18.96</td>
<td>596</td>
</tr>
<tr>
<td>Firm average hedge ratios</td>
<td>6.14*** (0.000)</td>
<td>3.72*** (0.000)</td>
<td>19.63</td>
<td>1432</td>
</tr>
<tr>
<td>Industry average hedge ratios</td>
<td>6.30*** (0.000)</td>
<td>4.05*** (0.000)</td>
<td>19.67</td>
<td>1374</td>
</tr>
<tr>
<td>AR(4) model</td>
<td>5.66*** (0.000)</td>
<td>2.93*** (0.000)</td>
<td>19.29</td>
<td>1062</td>
</tr>
<tr>
<td>MA(4) model</td>
<td>5.40*** (0.000)</td>
<td>2.20*** (0.000)</td>
<td>20.07</td>
<td>1027</td>
</tr>
</tbody>
</table>

| **Panel B: summary statistics of selective hedge cash flows ($/hedged ounces)** |         |          |                |    |
| Cragg model                                    | 1.21** (0.022) | 0.34*** (0.001) | 12.86          | 596 |
| Firm average hedge ratios                      | 0.14 (0.691)   | 0.00 (0.274)   | 13.29          | 1432|
| Industry average hedge ratios                  | 0.17 (0.649)   | 0.00 (0.311)   | 13.52          | 1374|
| AR(4) model                                    | 0.39 (0.346)   | 0.03 (0.235)   | 13.30          | 1062|
| MA(4) model                                    | 0.84 (0.070)   | 0.10** (0.041) | 14.93          | 1027|

*** and ** indicate significance at the 1% and 5% levels, respectively.
are statistically significant at the 5% level. We find positive selective hedge cash flows only when gold prices are falling.

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 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 have no reason to expect firms to be able to consistently outperform the market by timing it. We repeat 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. Our results remain unchanged.

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 should yield positive returns on average. This is indeed the case over our sample period. Panel A of Table 7 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

---

8The different results across the different methodologies for calculating the predicted hedge ratio benchmarks, together with their overall noisiness, could reflect our inability to precisely measure the selective element of hedging. It is especially noteworthy that the Cragg model, which arguably provides the most accurate measure of selective hedging, suggests that firms realized statistically and economically significant positive cash flow gains from selective hedging in both periods of rising gold prices.
Table 7
Risk premia in the gold market

Panel A 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 estimate the risk premia using measurements at both monthly and quarterly intervals. The results are virtually identical. Therefore, we report only the monthly results. Panel B 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.


<table>
<thead>
<tr>
<th>Hedge horizon ((T-t)) in years</th>
<th>Risk premium (in US$)</th>
<th>Risk premium (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( N )</td>
<td>Mean</td>
</tr>
<tr>
<td>1</td>
<td>272</td>
<td>24.99*** (4.35)</td>
</tr>
<tr>
<td>2</td>
<td>260</td>
<td>36.00*** (10.49)</td>
</tr>
<tr>
<td>3</td>
<td>247</td>
<td>39.62*** (15.36)</td>
</tr>
<tr>
<td>4</td>
<td>235</td>
<td>42.11*** (16.80)</td>
</tr>
<tr>
<td>5</td>
<td>223</td>
<td>44.76*** (19.37)</td>
</tr>
</tbody>
</table>

### Panel B: determinants of realized risk premia (based on returns of 1-year future contracts held to maturity)

<table>
<thead>
<tr>
<th>Intercept</th>
<th>Market return</th>
<th>SML</th>
<th>HML</th>
<th>Gold return</th>
<th>( N )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0.059*** (10.09)</td>
<td></td>
<td></td>
<td>-0.913*** (−58.77)</td>
<td>271</td>
<td>0.98</td>
</tr>
<tr>
<td>II</td>
<td>0.058*** (9.51)</td>
<td>0.013 (0.52)</td>
<td></td>
<td>-0.914*** (−58.35)</td>
<td>271</td>
<td>0.98</td>
</tr>
<tr>
<td>III</td>
<td>0.057*** (8.58)</td>
<td>0.013 (0.43)</td>
<td>0.032 (0.80)</td>
<td>0.004 (0.12)</td>
<td>-0.916*** (−58.91)</td>
<td>271</td>
</tr>
</tbody>
</table>

*** and ** indicate significance at the 1% and 5% levels, respectively.

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 would have earned $36 per ounce per year on average, increasing to $45 per ounce year for five-year contracts. On average, forward prices exceed future spot prices by about 6% per annum. 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. The presence of positive risk premia at least partly explains why the price increase from March 1993 to March 1996 did not result in large losses to firms that hedged their gold price risk. Another reason could be the increasing substitution of spot-deferred contracts for forward contracts during this period. Spot-deferred contracts allow firms to defer the realization of losses. By March 1993, only 5% of the total hedge position of our sample was in forward contracts, while 35% was in spot-deferred contracts. The risk premium acts as a buffer against losses due to a rising gold price. Thus, even if the gold price rises, a short forward contract may still be closed out at a price that exceeds the prevailing spot price. This was frequently the case for forward contracts maturing during the March 1993 to...
March 1996 period. This risk premium benefit was especially strong when a firm employed long-dated contracts.

We analyze the determinants of the observed risk premia in Panel B of Table 7. We regress the one-year realized risk premium on the three Fama–French factors and the gold return. The one-year risk premium is calculated as the return from holding one-year futures contracts until maturity. We repeat the analysis using the holding-period returns of two-, three-, four-, and five-year futures contracts, and obtain very similar results. 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% per annum. 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. We also repeat the risk premium analysis following the approach of Bessembinder (1992)—instead of calculating the returns from holding futures contracts until maturity, we calculate the monthly returns of short futures positions. The results are consistent with our findings in Panel B.

Fig. 3 plots the realized risk premia in the gold market for the period 1979–2003. The realized risk premia calculated using three-, four-, and five-year futures contracts are always positive except at the very beginning of the period, when the gold price increased dramatically. Risk premia calculated using one- and two-year futures contracts are mostly positive throughout this 24-year period. Indeed, during the 1989–1999 period of our derivatives sample, only the one- and two-year contracts entered into in 1992 and 1993 would have turned out to be unprofitable.

\[
\frac{1 + (F(t, T) - S(T))/F(t, T)}{(T-t)} - 1 \quad \text{for} \quad (T-t) = 1, 2, 3, 4, 5 \text{ years, where} \ F(t, T) \text{ is the gold forward price of a} \ (T-t)\text{-year contract at time} \ t, \text{and} \ S(T) \text{ is the gold spot price at time} \ T.
\]
In sum, gold producers that sold gold in the forward market have benefited handsomely from a persistent positive risk premium. The situation here is somewhat analogous to the case of Metallgesellschaft (MG) that we discuss in Section 4, since MG chose to buy futures contracts to benefit from the persistent negative basis in oil futures instead of hedging its exposure through spot market purchases. The difference between the experience of MG and our sample of 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 futures can lock in a price advantage in the basis, a seller of futures will face uncertainty about the realized value of the risk premium. Note that 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.

A derivatives strategy designed to exploit an expected positive risk premium implies significant risks to a trader. Even though in the long run a trader would book profits, in the short run he may face losses that can be large enough to cause financial distress. Buying the underlying commodity in the spot market and storing it in order to hedge this risk is not an option for a trader, as this would entail significant cash outlays and storage costs. In contrast, physical reserves provide producers a comparative advantage over traders in implementing such a strategy. A loss on the derivatives position would always be offset by a gain in the value of the physical commodity. However, even producers may face a liquidity crisis if the market moves sharply against them, as in the cases of Ashanti Gold and Cambior that we note previously. Nonetheless, traders have a much higher likelihood of experiencing such liquidity crises, making it more difficult for them to benefit from an expected positive risk premium.

5.4. Cross-sectional variation in selective hedge cash flows

We now return to examining the gains from selective hedging. The results in Tables 5 and 6 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 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 than $5 per ounce per quarter per hedge contract. Fig. 4 shows that the distribution of the selective hedge cash flows (using the Cragg model predicted hedge ratio benchmark) is symmetric and centered near zero.

In Fig. 5, we plot the industry mean and median selective hedge cash flows (derived from the Cragg model) over time. The one-sample runs test of randomness, described in Siegel and Castellan (1988), reveals that neither time series can be distinguished from a random draw. This implies that the industry as a whole is not gaining from selective hedging.

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 1994–1997 period. The finding that firms are more willing to speculate when derivatives portfolios generate a lot of extra cash is consistent with the predictions of Stulz (1996).

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 previously, firms that typically hedge either 100% of their output or nothing at all have less flexibility to hedge selectively than firms that typically hedge about 50% of output. Therefore it is possible that any relation between selective hedge cash flows and hedge ratios could be nonlinear. 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, the hedge ratio volatilities, and firm size. Since derivatives cash flows increase 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 has any statistical significance. Thus, selective hedge cash flows do not seem to be related systematically to how much firms hedge or the

Table 8
Determinants of selective hedge cash flows

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

$$
\text{Selective hedge cash flow} = a + b \times \text{hedge ratio}(x) + c \times [\text{hedge ratio}(x)]^2 + d \times \text{hedge ratio volatility}(x) + e \times \text{realized one-year risk premium} + \ln(\text{firm size}) + e,
$$

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. Panel B presents the regression results of the standardized difference between the actual and 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.

**Panel A: selective hedge cash flow regressions**

<table>
<thead>
<tr>
<th>Dependent variable: selective hedge cash flow per ounce of gold hedged (Cragg model)</th>
<th>$x = 1$</th>
<th>$x = 2$</th>
<th>$x = 3$</th>
<th>$x = 4$</th>
<th>$x = 5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.11</td>
<td>1.51</td>
<td>4.31</td>
<td>3.36</td>
<td>3.96</td>
</tr>
<tr>
<td>(0.61)</td>
<td>(0.42)</td>
<td>(1.35)</td>
<td>(1.30)</td>
<td>(1.27)</td>
<td></td>
</tr>
<tr>
<td>Hedge ratio ($x$)</td>
<td>4.00</td>
<td>−0.29</td>
<td>−6.08</td>
<td>−6.38</td>
<td>−2.29</td>
</tr>
<tr>
<td>(1.35)</td>
<td>(−0.10)</td>
<td>(−0.93)</td>
<td>(−0.83)</td>
<td>(−0.52)</td>
<td></td>
</tr>
<tr>
<td>[Hedge ratio ($x$)]^2</td>
<td>−2.21</td>
<td>−0.76</td>
<td>5.63</td>
<td>6.07</td>
<td>1.60</td>
</tr>
<tr>
<td>(−1.27)</td>
<td>(−0.50)</td>
<td>(0.79)</td>
<td>(0.60)</td>
<td>(0.60)</td>
<td></td>
</tr>
<tr>
<td>Hedge ratio volatility ($x$)</td>
<td>−2.12</td>
<td>0.62</td>
<td>−7.38</td>
<td>−7.37</td>
<td>−0.54</td>
</tr>
<tr>
<td>(−0.34)</td>
<td>(0.11)</td>
<td>(−1.01)</td>
<td>(−1.00)</td>
<td>(−0.09)</td>
<td></td>
</tr>
<tr>
<td>Risk premium</td>
<td>16.94**</td>
<td>20.89***</td>
<td>20.77***</td>
<td>19.76***</td>
<td>14.22*</td>
</tr>
<tr>
<td>(2.40)</td>
<td>(2.89)</td>
<td>(2.79)</td>
<td>(2.62)</td>
<td>(1.73)</td>
<td></td>
</tr>
<tr>
<td>Log (firm size)</td>
<td>−0.437</td>
<td>0.258</td>
<td>0.426</td>
<td>0.279</td>
<td>0.553</td>
</tr>
<tr>
<td>(−0.34)</td>
<td>(0.11)</td>
<td>(−1.01)</td>
<td>(−1.00)</td>
<td>(−1.11)</td>
<td></td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>0.01</td>
<td>0.011</td>
<td>0.017</td>
<td>0.018</td>
<td>0.001</td>
</tr>
<tr>
<td>$F$-value ($p$-value)</td>
<td>1.89</td>
<td>2.06</td>
<td>2.51</td>
<td>2.39</td>
<td>1.04</td>
</tr>
<tr>
<td>(0.095)</td>
<td>(0.070)</td>
<td>(0.030)</td>
<td>(0.038)</td>
<td>(0.395)</td>
<td></td>
</tr>
<tr>
<td>$N$</td>
<td>468</td>
<td>458</td>
<td>436</td>
<td>389</td>
<td>365</td>
</tr>
</tbody>
</table>

**Panel B: hedge ratio residuals regressions**

<table>
<thead>
<tr>
<th>1-year Hedge ratio ($t$)</th>
<th>2-year Hedge ratio ($t$)</th>
<th>3-year Hedge ratio ($t$)</th>
<th>4-year Hedge ratio ($t$)</th>
<th>5-year Hedge ratio ($t$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>−0.0007</td>
<td>0.0008</td>
<td>−0.004</td>
<td>0.003</td>
</tr>
<tr>
<td>(−0.02)</td>
<td>(0.02)</td>
<td>(−0.07)</td>
<td>(0.04)</td>
<td>(0.19)</td>
</tr>
<tr>
<td>Gold return ($t + 1$)</td>
<td>−0.0714</td>
<td>0.1031</td>
<td>−0.7448</td>
<td>0.36</td>
</tr>
<tr>
<td>(−0.10)</td>
<td>(0.12)</td>
<td>(−0.76)</td>
<td>(0.28)</td>
<td>(1.17)</td>
</tr>
<tr>
<td>Adj. $R^2$</td>
<td>−0.002</td>
<td>−0.002</td>
<td>−0.001</td>
<td>−0.004</td>
</tr>
<tr>
<td>$N$</td>
<td>526</td>
<td>418</td>
<td>330</td>
<td>218</td>
</tr>
</tbody>
</table>

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
frequency with which they adjust their hedge ratios. We also find no significant relation between selective hedge cash flows and firm size.

As argued in Section 2.1, 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 a change in the risk premium 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 reported in Panel B of Table 8 indicate that none of the models have any explanatory power, i.e., there is no significant relation between the selective component of the hedge ratio and the realized risk premium.

In unreported analysis, we investigate whether firms change their hedge ratios in response to observed changes in three market variables, namely, the gold spot price, the gold lease rate, and the basis (forward price minus current spot price). We find that firms decrease their hedge ratios in response to past increases in the gold price and the gold lease rate, and increase their hedge ratios in response to past increases in the basis. In contrast, as shown in Panel B of Table 8, we find no evidence that firms are able to successfully predict future changes in risk premia, which ultimately determine the profitability of their selective hedging activity.

There are three major gold price trend reversals during our sample period: March 1993 (price increase), March 1996 (price drop), and December 1999 (price increase). We investigate whether mining firms as a group were able to anticipate these turnarounds, adjusting their hedge positions up to one year before each turnaround. One might expect mining firms to reduce the total size of their hedge books prior to an increase in the gold price, and vice versa. What we observe, however, is the opposite: average quarterly increases in total hedging positions of 14% and 10% prior to the March 1993 and December 1999 price increases, respectively, and an average quarterly decrease of 2% prior to the March 1996 gold price downturn.

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 within the group. 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. However, we find no evidence that this might be the case.

In summary, we find no convincing evidence that firms consistently outperform the market by hedging selectively. On the one hand, we see 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 examine the basic premise in the risk management literature that derivatives transactions have zero intrinsic net worth. We 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 firms to use 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 aimed at 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 documents 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 on corporate risk management. Thus, our study provides focus for a new and potentially fruitful area of research.

**Appendix A. 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.\(^9\) 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.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 equation

\[
N_t = N_{t-1} + c_t.
\]

If \(c\) is positive, the firm increases its derivatives position and if \(c\) is negative, it decreases its derivatives position. If \(c_t \neq 0\), then the reported delivery prices \(X_t\) and \(X_{t-1}\) are related by the equation

\[
X_t = \frac{N_{t-1}X_{t-1} + c_tX_t^i}{N_t},
\]

where \(X_t^i\) denotes the inferred delivery price that corresponds to the net change \(c\). Solving for \(X_t^i\) yields

\[
X_t^i = \frac{N_tX_t - N_{t-1}X_{t-1}}{c_t}.
\]

\(^9\)We ignore contingent forwards, variable forwards, short positions in puts, and long positions in calls. While a few firms started using these less conventional strategies in 1999, the last year in our sample, the positions were negligible.
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

\[
\text{Linear } CF_t = -c_t(X_t^i - \bar{F}_t) \times e^{-rT},
\]
(A.4)

where \(\bar{F}_t\) 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,

\[
\text{Linear } CF_t = -c_t(X_t^i - \bar{S}_t).
\]
(A.5)

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

\[
\text{Linear } CF_t = N_t(X_{t-1} - X_t) \times e^{-rT}.
\]
(A.6)

A.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 we 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 under identical market conditions, in order to infer cash flows rather than profits from a change in a firm’s options positions. The cash flows from a firm’s put options positions, which mature in more than three months, are given by

\[
\text{Put } CF_t = CF \text{ from liquidating options position } \\
- CF \text{ from buying new options position }
\]

\[
\text{Put } CF_t = N_{t-1} \times f(Y_{t-1}, T_{t-1} - 1.5; \bar{S}_t, \bar{r}_t, \bar{\sigma}_t, \bar{\gamma}_t) - N_t \\
\times f(Y_t, T_t + 1.5; \bar{S}_t, \bar{r}_t, \bar{\sigma}_t, \bar{\gamma}_t),
\]
(A.7)

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

\[
\text{Put } CF_t = N_{t-1} \times \max(0, Y_{t-1} - \bar{S}_t).
\]
(A.8)

The corresponding cash flows from call positions are

\[
\text{Call } CF_t = -(N_{t-1} \times f(Y_{t-1}, T_{t-1} - 1.5; \bar{S}_t, \bar{r}_t, \bar{\sigma}_t, \bar{\gamma}_t) - N_t \\
\times f(Y_t, T_t + 1.5; \bar{S}_t, \bar{r}_t, \bar{\sigma}_t, \bar{\gamma}_t)),
\]

\[
\text{Call } CF_t = -N_{t-1} \times \max(0, \bar{S}_t - Y_{t-1}).
\]
(A.9)
The aggregate derivatives cash flow (Total CF) is given by the summation of the cash flows of all outstanding positions:

\[ \text{Total } CF_t = \sum \text{Linear } CF_t + \sum \text{Option } CF_t. \] \hspace{1cm} (A.10)

A.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 in order to avoid double counting (i.e., to account for the possibility of a forward contract being replicated by a put and a call), i.e.,

\[ NT = N(\text{forward}) + N(\text{spot deferred}) + N(\text{loan}) + \max\{N(\text{put}), N(\text{call})\}. \hspace{1cm} (A.11) \]

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 \(NT_t/C_0\) 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

\[ \text{Total } CF_{NT_t} = \frac{\text{Total } CF_t}{\max\{NT_t, NT_{t-1}\}}. \hspace{1cm} (A.12) \]

References


