Abstract

This paper explains corporate hedging and speculation in a two period rational expectations model. A risk averse manager represents a firm that is priced in a risk neutral market. The manager enters into a cash flow hedge of a forecast transaction by taking a short position in the futures market. When the futures position is chosen, the manager possesses private information regarding the firm’s production capacity. Mandatory disclosure of the futures position in the financial statements allows the market to draw inferences over the manager’s information. These inferences affect the market’s pricing decision and in turn the manager’s hedging decision. The futures position taken is chosen not only to reduce price risk exposure but to signal some capacity level. In equilibrium, however, the market anticipates the manager’s strategy and is not fooled.

Considering varying managerial preferences, we analyze three settings. In the basic setting speculation occurs whenever the manager prefers high market values in both periods. In the second setting we add transaction costs and find that speculation is less likely. Finally, we introduce uncertainty regarding the manager’s preferences. If the market needs to determine prices based on expected preferences, incentives to speculate are mitigated in equilibrium but still present.

Keywords: Derivatives, Hedging, Hedge Accounting, Speculation
1 Introduction

The issue of corporate risk management has received considerable attention by economists and accountants over the last two decades. At first sight capital market theory suggests that risk management on a corporate level is of no value - at least for widely-held companies. Shareholders of such companies typically hold well diversified portfolios of securities and corporate risk management can at best be non value destroying. Empirical evidence, however, is in sharp contrast with such considerations as it shows that firms heavily use derivatives markets for risk management. Responding to this polarity a number of contributions to the literature identified situations for corporate hedging to be valuable, including the presence of non linear tax codes and bankruptcy costs as well as, probably most important, the existence of risk averse managers combined with asymmetric information. While providing a rationale for hedging as one type of risk management, these contributions are not suitable to explain speculative activities. In fact the models employed find that speculation is undesirable and would not occur. Again, contrary to theory, at least anecdotal evidence speaks a different language. The best known example might be the collapse of the Barings Bank in 1995. But also Dell Computers, Procter & Gamble and Metallgesellschaft reported huge losses in the past apparently due to speculation. Moreover, the accounting treatment of financial derivatives and hedging according to US-GAAP and IFRS suggests that standard setters worry about speculation and therefore aim at ensuring particular transparency concerning derivatives usage in the financial statements. This is reflected in mandatory fair value measurement and extensive disclosure rules for derivatives on the one hand and in very restrictive conditions for hedge accounting on the other hand. In particular, firms are required to disclose information necessary for users of financial statements to assess the amounts, timing and certainty of future cash flows associated with a financial instrument or classes of...
similar financial instruments. Application of hedge accounting rules requires detailed documentation of the hedging relationship and its effectiveness as well as disclosure of the nature of the hedge, the hedged item, and the hedging instrument. Especially the requirement of a hedge to be highly effective associated with ongoing documentation of that fact apparently aims at avoiding that speculative positions taken by firms are disguised as hedging activities in the financial statements.

Following these arguments, this paper attempts to explain not only hedging but speculation in a rational expectations model. We consider a firm that plans to sell a product some period ahead and enters into a cash flow hedge of a forecast transaction. The quantity in units of the product to be available for sale is uncertain, but the manager of the firm has private information regarding that quantity at the inception of the hedge. To reflect comprehensive disclosure rules for derivatives as described above, we assume that the manager has to report his position in the derivatives market truthfully, no matter whether hedge accounting rules are applied or not. If hedge accounting is used, however, the manager evidently has some discretion due to his private information. E.g. he may designate all derivatives bought as a hedge, even though he truly expects either a higher or lower quantity to be sold than he actually “hedged”. If the true quantity is lower, the manager in fact takes a speculative position, if it is higher a (partial) hedge is performed.

We assume that the firm is represented by a risk averse manager and priced in a risk neutral market. That way we create a setting in which hedging is typically beneficial from the manager’s / the firm’s perspective while speculation is detrimental. However, the manager’s choice and report of a certain position taken in the derivatives market conveys at least part of his private quantity information to the market and therefore affects firm valuation. This effect may create an incentive for the manager to “overhedge” that is to take a speculative position.
The market infers the manager’s strategy and corrects the market price for the perceived overstatement. Nonetheless, in equilibrium the manager speculates and incurs personal costs. The inefficient equilibrium of course arises due to the inability of the manager to directly and credibly report his private information and due to the requirement for disclosure of the derivatives market position.

Other models that explain not only hedging but also speculation include DeMarzo/Duffie (1995), Melumad et al (1999) and Barnes (2001). DeMarzo/Duffie employ a two period model in which the owners of a firm hire a manager based on single period contracts. The firm’s first period profit conveys information about the manager’s ability that is unknown to both parties and influences the second period contract offer. If the manager hedges first period outcome, the resulting reduction in noise increases the sensitivity of second period payment to first period profit. From an ex ante perspective hedging therefore increases the manager’s second period income risk. In such a setting it might be optimal for a manager to garble first period profit rather than to hedge, which corresponds to speculation.

Melumad et al assume a risk averse market maker and risk averse investors. In their model taking a speculative position is optimal from the investors’ point of view, if their degree of risk aversion is lower than the one of the market maker. Hedging is optimal if the opposite is true.

Finally Barnes analyzes a signalling game with two types of firms in a market, good firms and bad firms. Only the good firms face a hedging opportunity. Given that investors can neither distinguish good versus bad firms nor whether derivatives are used for hedging purposes or for speculation, bad firms may have an incentive to speculate to imitate good firms and to be priced in a pooling equilibrium.
Evidently, all three papers discussed above identify incentives for speculation in settings very different from ours. Our model is but closely related to the ones presented in Fischer/Verrecchia (2000) and Ewert/Wagenhofer (2005). Both papers discuss issues of earnings management rather than risk management. While Fischer/Verrecchia use a single period setting with uncertain managerial preferences to provide a rationale for reporting biases, Ewert/Wagenhofer extend the model to two periods to analyze the effect of tighter accounting standards. In our model we cover two periods and allow for uncertain preferences in section 5.2. In contrast to both papers we introduce a risk averse manager.

The paper proceeds as follows. Section 2 presents the details of our basic model. Section 3 considers a simplified setting that is instructive for further analysis. Section 4 determines equilibrium strategies for the basic model. In section 5 we extend the model to include alternatively transaction costs or uncertainty regarding the manager’s preferences. Our results are summarized in section 6.

2 The Model

We consider a two period - three date game with two strategic players. A risk neutral capital market and a risk averse manager of a firm. The firm has been founded at $t = 0$ and will be liquidated at $t = 2$. It is priced in the market based on its expected terminal cash flow.

An investment at $t = 0$ that is immediately sunk allows to produce a product that will generate uncertain cash flows in period 2. In fact price $p$ and quantity $x$ of the product produced are subject to random shocks:

\[ p = \mu_p + \eta \text{ with } \eta \sim N(0, \sigma_\eta^2) \quad \text{and} \]
\[ x = \mu_x + \epsilon_1 + \epsilon_2 \text{ with } \epsilon_i \sim N(0, \sigma_i^2), \quad i = 1, 2. \]
All random variables are assumed to be jointly independent thus $Cov(\varepsilon_1, \varepsilon_2) = 0$ and $Cov(\eta, \varepsilon_i) = 0$.\textsuperscript{6}

We assume that the firm’s product is traded in a well-functioning market with publicly observable prices. The firm itself is a price taker in the sense that the product’s price is determined by market conditions and is unaffected by any activity of the firm. It’s exposure to price risk, however, can be perfectly hedged in the futures market. As the market is risk neutral, no risk premium will be charged. Moreover, we set the riskless interest rate to zero without loss of generality so that discounting has no role.\textsuperscript{7} For simplicity we further assume that one futures contract calls for transfer of one unit of the firm’s product. $z$ denotes the number of futures contracts the manager enters into.

Given these assumptions the manager may hedge the price risk exposure by taking a short position in the futures market. If the number of futures $z$ entered into ends up to be identical to the number of units $x$ produced and sold in period two, the hedge is perfect in the sense that cash inflow in period two is completely determined in period one. This result holds, no matter whether the manager fulfills the futures contracts by delivery of the goods or sells in the spot market and closes the futures position in cash. However, if $x$ turns out to be below $z$ in period two, the firm is left with an open position in derivatives, which corresponds to speculation. On the other hand, if $z$ is below $x$ only a partial hedge has been performed.

The quantity $x$ of the product that can be produced and sold depends on firm specific factors. E.g. production capacity depends on the specific technology chosen, on successful implementation of this technology or on it being operated smoothly.

In period 1 the manager receives a private signal $y$ that reveals part of the production uncertainty. E.g. some preliminary tests of the production technology allow to better estimate
future production capacity. We define $y = \mu_x + \varepsilon_1$ being normally distributed with $y \sim N(\mu_x, \sigma_1^2)$. The manager observes the realization of $y$ and updates his beliefs w.r.t. $x$ to get $E(x|y) = \mu_x + \varepsilon_1 = y$ and $\text{Var}(x|y) = \sigma_2^2$.

Over the life of the firm two reports $R_i, i=1,2$ are to be published. These reports can be regarded as the firm’s annual financial statements. Even though we presume an effective audit, we realize that financial statements typically contain information of varying quality and are not exhaustive. While pieces of the information given can be regarded as perfectly reliable, others involve estimates and might be biased. Some information the firm possesses is conveyed only indirectly and some cannot be communicated at all in a financial report.

The first report $R_1$ is due at the end of the first period, immediately after the manager has fixed the futures position. It reports truthfully the futures position chosen but not the privately observed signal $y$. The signal $y$ is regarded as one of those pieces of information mentioned above, that cannot possibly enter a financial statement e.g. because it is not sufficiently specific to be quantified and to be audited.

In the second period the cash flows from the investment project are realized and the futures position is either fulfilled by delivery of the goods or closed. The firm publishes a second report $R_2$ that truthfully and reliably reveals the terminal cash flow $C_2$.

The following timeline summarizes the course of the game:

Insert Figure 1 here

The market is assumed to be perfectly competitive and rational. Market prices at $t = 1$ and $t = 2$ therefore correspond to the market’s rational expectations w.r.t. the firm’s terminal value
given the information present at each point in time $P_t = E(C_t|t)$. At $t = 1$ the market is aware of the fact that the manager has privately learned $y$.

The manager chooses the futures position $z$ to maximize his objective function $OF$. We assume that his preferences can be represented by a mean-variance objective function defined on the firm’s market values $P_1$ and $P_2$ as follows:

$$OF = E(wP_1 + P_2) - \frac{r}{2} Var(wP_1 + P_2)$$

The parameter $r > 0$ refers to the manager’s degree of risk aversion. The weight parameter $w$ attached to $P_1$ will be discussed in detail below.

In period 1, when the hedging decision is made, $P_1$ is a deterministic function of the manager’s report and the market’s beliefs which implies $E(wP_1) = wP_1$ and zero variance. In contrast $P_2$ at this point is a random variable, dependant on $\varepsilon_2$ and $\eta$. Accordingly, we can reformulate the manager’s objective function to obtain:

$$OF = wP_1 + E(P_2) - \frac{r}{2} Var(P_2)$$

The characteristics of this objective function are crucial for what follows and therefore need to be discussed in some detail: Most of the literature presumes that managers prefer higher firm values to lower ones. Arguments in favour of this presumption are manifold. E.g. managerial performance evaluation is frequently based on firm value, managers are granted stock options or hold their firm’s shares themselves, and, last but not least, high market values are perceived to improve managers’ future career perspectives. In our two period model these arguments are certainly convincing with respect to the terminal firm value and we account for this defining $OF$ to be increasing in $P_2$. Very likely related arguments hold for $P_1$, resulting in preferences for higher interim firm value. E.g. managers are frequently evaluated or paid
depending on firm value in each period or believe that constantly high market values are relevant for their future careers. However, special circumstances may arise to reverse these interim preferences. E.g. a manager would possibly prefer a low firm value if he expects additional stock options to be granted in the near future to warrant a low exercise price. Alternatively, a newly appointed manager may expect to be able to blame bad results at the end of his first period on the former management and would rather want to achieve material increases in value than constantly high stock prices. Similar incentives could be created if the manager is evaluated or paid based on a change in firm value.\textsuperscript{11}

To be able to account for both types of preferences in $t = 1$ we introduced the parameter $w$. $w > 0$ reflects the conventional setting in which the manager prefers higher firm values to lower ones. If $w < 0$ the opposite is true. Moreover, including $w$ allows to map different managerial preferences for $P_1$ relative to $P_2$. Depending on whether $|w|$ is above or below one, the manager will either be more concerned over $P_1$ or $P_2$.\textsuperscript{12} For now the objective function is assumed to be common knowledge.

3 A simplified setting: A degenerate game without intermediate reporting

Before we go on to analyze the game described above, it is instructive to go back to a simpler setting without intermediate reporting. To do so, we assume for the moment that no report $R_1$ is published, while the market inevitably learns the terminal cash flow at $t = 2$ due to observation of $R_2$.

As $R_1$ is the only source of information up to $t = 1$, its absence implies that the market’s information level at $t = 1$ equals the one at $t = 0$ and therefore $P_1$ equals $P_0$.

$$ P_1 = \mu_p \mu_s $$ (1)
At $t = 2$ the market has learned actual cash flows and the firm’s market price is revised accordingly:

$$
P_2 = C_2 = \left(\mu_p + \eta\right)(\mu_x + \epsilon_1 + \epsilon_2 - z) + \mu_p z = \left(\mu_p + \eta\right)(\mu_x + \epsilon_1 + \epsilon_2) - z\eta
$$

(2)

The manager chooses $z$ after he has observed $y$, that is after he has revised his expectations w.r.t. production capacity. To account for this, we define $z = y + b$ and focus on $b$ rather than $z$ in what follows. $b$ can be either positive or negative to capture whether the manager in expectations “overhedges”, thus takes a speculative position ($b > 0$) or performs a partial hedge ($b < 0$). The manager’s optimization problem is formalized in (3):

$$
b^\ast \in \arg \max_b wP_1 + E(P_2 | y) - \frac{r}{2} Var(P_2 | y)
$$

(3)

As the manager is aware of the market’s pricing strategy at $t = 2$ we get

$$
E(P_2 | y) = \mu_p (y - (y + b)) + \mu_p (y + b) = \mu_p y
$$

(4)

The variance of $P_2$ given the manager’s information is

$$
Var(P_2 | y) = \sigma_2^2 \left(\mu_p^2 + \sigma_\eta^2\right) + b^2 \sigma_\eta^2
$$

(5)

Inserting into the manager’s objective function yields:

$$
OF(b) = w\mu_p \mu_x + \mu_p y - \frac{r}{2} \left[\sigma_2^2 \left(\mu_p^2 + \sigma_\eta^2\right) + b^2 \sigma_\eta^2\right]
$$

(6)

We take the derivatives w.r.t. $b$ to get the following first and second order conditions:

$$
OF'(b) = -r \sigma_\eta^2 b = 0
$$

(7)

$$
OF''(b) = -r \sigma_\eta^2 < 0 \text{ for all } b
$$

(8)

It follows that $b^\ast = 0$ is a maximum for all realizations of $y$ and for all $w$.  

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**Observation 1:** If there is no report $R_1$, and thus $z$ is not revealed at $t = 1$, it is optimal for the manager to choose $z = y$ and $b^* = 0$.

Observation 1 essentially covers two aspects. First, it shows that at the optimum the manager hedges the complete expected price risk exposure. This result is driven by the manager’s risk aversion. As hedging is costless, the manager minimizes the firm’s risk exposure and at the same time his personal risk premium. Second, the manager’s hedging choice depends on his private information. If $z$ was reported or otherwise observed, given the manager’s choice, the market could infer $y$ from observing $z$.

### 4 The basic setting: A linear rational expectations equilibrium

Having clarified the effect of $y$ on $z$ in a no-intermediate-reporting setting, we proceed in determining a rational expectations equilibrium given a report $R_1$ is published. The results above suggest that a rational market would use a report $z$ not only to revise its expectations regarding the futures position chosen by the firm, but also to revise expectations with respect to the manager’s private information on production quantity. However, a rational manager would certainly anticipate the market’s strategy and consider it when choosing $z$.

Including this argument, the market’s pricing strategy at $t = 1$ incorporates $z$ as well as a conjecture for $b$, having observed $z$. The conjecture is indicated by a caret.

$$P_1 = E(C_2|z, \hat{b}) = \mu_p(E(x|z, \hat{b}) - z) + \mu_p z = \mu_p E(x|z, \hat{b})$$

At $t = 2$ the market price $P_2$ will reflect perfect information about $C_2$ similar to the simplified setting above.

$$P_2 = C_2 = (\mu_p + \eta)(\mu_x + \epsilon_1 + \epsilon_2) - z \cdot \eta$$
The manager now chooses his futures position based not only on his private information but also on his conjecture about the market’s pricing strategy in $t = 1$.

$$b^* \in \arg \max_b \left( \hat{P}_1 + E(P_2|y) - \frac{r}{2} Var(P_2|y) \right)$$

(11)

In equilibrium, however, the conjectures of both parties have to be correct:

$$\hat{P}_1 = P_1,$$

and $\hat{b} = b$

Similar to a number of other contributions to the literature, we restrict our attention to linear equilibria in what follows. Our normal distribution assumptions ensure that the market’s inferences regarding firm value at $t = 1$ that are reflected in $P_1$ are a linear function of $z$:

$$P_1(z) = \mu_p(\alpha z + \beta)$$

(12)

Moreover, we assume that the manager’s strategy is a linear function in his private information, $y$:

$$b(y) = \gamma y + \delta$$

(13)

The manager anticipates that the market’s pricing strategy is a function in $z$ of the form presented in (12). This implies the following managerial conjecture of firm value at $t = 1$:

$$\hat{P}_1 = \mu_p(\hat{\alpha} z + \hat{\beta})$$

(14)

Carets as before denote a conjecture. Based on these assumptions, the manager maximizes the following objective function w.r.t. $b$:

$$OF(b) = w_\mu \mu_p(\hat{\alpha} (y + b) + \hat{\beta}) + \mu_p y - \frac{r}{2}[\sigma_\alpha^2(\mu_p^2 + \sigma_\delta^2) + b^2 \sigma_\delta^2]$$

(15)

We obtain the following first and second order conditions:

$$OF'(b) = w_\mu \mu_p \hat{\alpha} - r \sigma_\delta^2 b = 0$$

(16)
\[ \text{OF}''(b) = -r \sigma_y^2 < 0 \quad \text{for all} \quad b \] (17)

The manager’s optimal strategy exhibits

\[ b^* = \frac{w \mu_p \hat{\alpha}}{r \sigma_y^2} \]

and we get for (13) \( \gamma = 0 \) and \( \delta = \frac{w \mu_p \hat{\alpha}}{r \sigma_y^2} \). \( b^* \) turns out to be a constant independent of the private information \( y \). The market realizes this fact and revises its expectations as follows:

\[ E(x \mid z, \hat{b}) = z - \hat{b} \] (18)

and \( P_1 = E(C_2 \mid z, \hat{b}) = \mu_p (\alpha z + \beta) = \mu_p (z - \hat{b}) \) (19)

with \( \alpha = 1 \) and \( \beta = -\hat{b} \)

However, in equilibrium the conjectures are self fulfilling and

\[ b^* = \frac{w \mu_p}{r \sigma_y^2} \] (20)

\[ P_1 = \mu_p (z - b^*) = \mu_p y \] (21)

We summarize our basic result in proposition 1.

**Proposition 1:**

There exists a unique linear equilibrium with the following characteristics:

(i) The market fully infers the private information \( y \) of the manager from observing \( z \).

(ii) If \( w \) is positive \( b^* \) is positive which corresponds to a speculative position in the futures market.

(iii) If \( w \) is negative \( b^* \) is negative which corresponds to a partial hedge.
In contrast to our results in the no-intermediate-reporting setting above, the manager chooses $b = 0$ if and only if $w = 0$, which characterizes the special case in which the manager’s preferences are unaffected by $P_1$. Whenever the manager prefers higher to lower firm value in $t = 1$, that is $w > 0$, he chooses a speculative position. He does not hedge fully if the opposite is true, $w < 0$.

A high number of futures contracts ceteris paribus signals favorable private information $y$ and in turn affects $P_1$. With $w \neq 0$ the manager cannot resist to exploit his informational advantage and to distort the report. Importantly, the manager maximizes his utility for given beliefs of the market, which implies that the incentive to bias prevails even though the market fully infers the hedging choice in equilibrium and corrects for $b^*$ in its pricing strategy. Given the assumed unobservability of $y$ and $w \neq 0$, it is always rational for the market to expect a distortion. Given the market’s expectations, the best the manager can do is in fact to choose $b^*$. For all $w \neq 0$, however, the position chosen is suboptimal in terms of minimizing the manager’s personal risk premium.

The distortion turns out to be greater the stronger the manager’s preferences for $P_1$, that is the higher $|w|$, and the lower the manager’s risk aversion. It is lower the higher the price risk $\sigma_{\eta}^2$. The costs in terms of additional risk premium to be paid in this setting may be incurred either by the manager or by the firm’s owners. Which party has to cover them depends finally on the distribution of bargaining power and is outside the model.

5 Two extensions of the model

According to our basic model as described above, the manager has an incentive to choose $z \neq y$ whenever $w$ is nonzero. Thus we are able to explain speculation as well as suboptimal
hedging. In particular the manager takes a speculative position whenever he prefers higher firm value in $t = 1$. This seemingly powerful result, however, has been derived from a very stylized model chosen particularly to identify first order effects. As such a framework is apt to neglect possibly important aspects, we are going to extend our model in two directions. In the following section we will include transaction costs and in section 5.2 we introduce uncertainty w.r.t. the manager’s preferences.

5.1 Extension 1: Including transaction costs

Even though our assumption of a risk neutral market precludes a risk premium involved with derivatives trading, it is reasonable to assume that hedging and speculation is costly due to transaction costs as e.g. certain fees to be paid. We model them as a proportional cost $c$ to be paid per futures contract the manager enters into.

In the presence of transaction costs the market learns not only $z$ but also $c$ from report $R_1$ and incorporates both into prices:

$$P_1 = E(c, z, \hat{b}_c) = \mu^c_p (E(x|z, \hat{b}_c) - z) + \mu_p z - cz = \mu_p E(x|z, \hat{b}_c) - cz$$

(9a)

$$P_2 = C_2 = (\mu_p + \eta)(\mu_x + \epsilon_1 + \epsilon_2) - z \cdot \eta - c \cdot z$$

(10a)

We distinguish the manager’s strategy in this setting from the basic strategy by using a subscript $c$. Everything else equal the manager’s objective function takes the following form:

$$OF(\hat{b}_c) = w[\mu_p (\hat{\alpha} (y + b_c) + \hat{\beta}) - c \cdot (y + b_c)] + [\mu_p y - c (y + b_c)] - r \left[ \frac{\sigma^2_p (\mu_p^2 + \sigma^2_\eta) + b^2 \sigma^2_\eta}{2} \right]$$

(15a)

We obtain the following first and second order conditions:

$$OF'(\hat{b}_c) = w(\mu_p \hat{\alpha} - c) - c - r \sigma^2_\eta b_c = 0$$

(16a)
\[ OF''(b_c) = -r \sigma^2_n < 0 \]  
\[ \text{(17a)} \]

Solving the first order condition for \( b_c \) yields:

\[ b_c^* = \frac{w(\mu_p \hat{\alpha} - c) - c}{r \sigma^2_n} \]

Again \( b^* \) turns out to be a constant, independent from the manager’s private information \( y \); \( \gamma = 0 \) and \( \delta = \frac{w(\mu_p \hat{\alpha} - c) - c}{r \sigma^2_n} \)

The market revises its expectations similarly to the basic model and we get:

\[ P_1 = \mu_p \cdot (\alpha z + \beta) - c \cdot z = \mu_p (z - \hat{b}_c) - c \cdot z \]  
\[ \text{(19a)} \]

with \( \alpha = 1 \) and \( \beta = -\hat{b}_c \)

And in equilibrium:

\[ b_c^* = \frac{w(\mu_p - c) - c}{r \sigma^2_n} \]  
\[ \text{and} \]

\[ P_1 = \mu_p y - cz \]  
\[ \text{(20a)} \]

\[ \text{(21a)} \]

**Proposition 2:**

There exists a unique linear equilibrium with the following characteristics:

(i) The market fully infers the private information of the manager \( y \) from observing \( z \).

(ii) If \( w(\mu_p - c) - c \) is positive \( b_c^* \) is positive which corresponds to a speculative position in the futures market.

(iii) If \( w(\mu_p - c) - c \) is negative \( b_c^* \) is negative which corresponds to a partial hedge.
From the solutions obtained we realize that \( b_c^* = 0 \) in this setting if and only if \( w = \frac{c}{\mu_p - c} \).

As transaction costs per unit \( c \) are certainly lower than the selling price per unit agreed upon in the futures market \( \mu_p \) we define \( \mu_p - c > 0 \). Accordingly, the special case \( b_c^* = 0 \) is achieved for \( w > 0 \), rather than for \( w = 0 \), which was our basic result from section 4. A speculative position is taken in this setting only if the manager cares heavily about maximizing \( P_1 \), that is for \( w > \frac{c}{\mu_p - c} \). For \( w \) lower or negative the manager performs a partial hedge in equilibrium.

Comparing the manager’s optimal futures position in both settings leads to the following expression and corollary 1.

\[
b^* - b_c^* = \frac{w\mu_p}{r\sigma_n^2} - \frac{w(\mu_p - c) - c}{r\sigma_n^2} = \frac{c(1 + w)}{r\sigma_n^2}
\]

Corollary 1:

The number of futures contracts the manager enters into in equilibrium for a given \( y \) is lower with than without transaction costs if \( w > -1 \). For \( w < -1 \) the opposite is true.

This result crucially depends on the fact that transaction costs reduce firm value in both periods by the same amount. Given \( w \) is positive, these costs harm the manager in each period and counteract the benefits he achieves from hedging/speculation. Ceteris paribus the manager enters into less futures contracts than in the basic setting. If \( w \) is negative, the decrease in \( P_1 \) from a higher futures position benefits the manager, while the decrease in \( P_2 \) is detrimental. If the manager values \( P_1 \) higher than \( P_2 \) in the sense that \( |w| > 1 \), the benefits
from incurring transaction costs more than outweigh the losses and in turn he chooses a futures position in the setting with transaction costs higher than in the basic setting.

5.2 Extension 2: Uncertainty regarding the manager’s preferences

So far we have treated the manager’s preferences as being perfectly known by the market. As preferences are typically unobservable and difficult to assess, we relax this assumption in what follows and allow for uncertainty regarding the weight parameter $w$. From now on we assume that the market believes $w$ is normally distributed with $w \sim N(\mu_w, \sigma_w^2)$ and $Cov(w, \varepsilon_i) = Cov(w, \eta) = 0$ for $i = 1, 2$.\textsuperscript{16}

The manager is assumed to know his own preferences similar to the settings above.

The rational market of course perceives, similar to the settings above, that the manager’s hedging choice will be a function of his private information, now $y$ and $w$. The manager in turn is aware of the market’s incomplete information and the resulting pricing strategy. Incorporating the uncertainty added into the market’s pricing strategy and the manager’s hedging strategy results in:

$$P_1 = E(C_2 \mid z, \hat{b}_w) = \mu_p E(x \mid z, \hat{b}_w)$$ \hspace{1cm} (9b)

$$P_2 = C_2 = (\mu_p + \eta)(\mu_v + \varepsilon_1 + \varepsilon_2) - z \cdot \eta$$ \hspace{1cm} (10b)

and

$$\hat{b}_{w^*} \in \arg \max_{b_w} w \hat{P}_1 + E(P_2 \mid y) - \frac{\rho}{2} Var(P_2 \mid y)$$ \hspace{1cm} (11b)

Assuming again linear strategies of both players, the market’s pricing strategy equals the one in the basic setting.
\[ P_1(z) = \mu_p (\alpha z + \beta) \]  

(12b)

The manager chooses \( b \) as a linear function of his private information \( y \) and \( w \):

\[ b_w(y, w) = \gamma y + \delta w + t \]  

(13b)

The manager’s objective function and first and second order conditions equal those in the basic setting and thus we obtain a well known result

\[ b_w^* = \frac{w \mu_p \hat{\alpha}}{r \sigma_\eta^2}. \]

The parameters stated in (13b) take on the following values:

\[ \gamma = 0, \; \delta = \frac{\mu_p \hat{\alpha}}{r \sigma_\eta^2} \; \text{and} \; t = 0. \]

It follows that, as in the basic setting, \( b_w^* \) is independent from \( y \). As before it is a linear function of \( w \), but now \( w \) is unknown to the market. This characteristic turns out to be crucial for the market’s conjecture as it prevents the market from inferring \( y \) from observation of \( z \). The market’s update yields the following results:

\[ \frac{\sigma_1^2}{\sigma_1^2 + \delta^2 \sigma_w^2} (z - \mu_x - \hat{\delta} \mu_w) \]  

\[ P_1 = \mu_p [\mu_x + \frac{\sigma_1^2}{\sigma_1^2 + \delta^2 \sigma_w^2} (z - \mu_x - \hat{\delta} \mu_w)] \]  

(18b)

(19b)

with \( \alpha = \frac{\sigma_1^2}{\sigma_1^2 + \delta^2 \sigma_w^2} \) and \( \beta = \mu_x - \alpha (\mu_x + \hat{\delta} \mu_w) \)

To characterize the equilibrium given the conditions above, we need to determine \( \alpha, \delta, \) and \( \beta \). As the solution turns out to be messy, we restrict ourselves to show that unique solutions for all parameters, and therefore a unique equilibrium, exists. The proof is given in appendix B. We summarize in proposition 3.
Proposition 3:

(i) There exists a unique linear equilibrium of the game.

(ii) The market is unable to fully infer the private information of the manager $y$ from observing $z$.

(iii) In equilibrium $0 < \alpha < 1$. This implies that $|b_w^*| > |b_w^*|$ for $w \neq 0$.

(iv) If $w$ is positive $b_w^*$ is positive which corresponds to a speculative position in the futures market. If $w$ is negative $b_w^*$ is negative which corresponds to a partial hedge.

The analysis above shows that in the presence of uncertainty w.r.t. the manager’s preferences the market is unable to infer the manager’s private information and to correct for it when pricing the firm at $t = 1$. Similarly to the basic setting $b^*_w = 0$ is achieved if and only if $w = 0$.

As $\alpha$ in this setting is lower than in the basic setting $|b^*_w| > |b^*_w|$ if $w$ is nonzero. Accordingly the distortion from the risk minimizing futures position in equilibrium is less severe than in the basic setting but is still present. The sensitivity of the price $P_1$ regarding $z$ decreases when the variance of the weighting parameter $w$, $\sigma_w^2$ increases. Overall, our qualitative result from the basic model is confirmed given uncertain preferences.

6 Conclusions

This paper uses a rational expectations model to explain corporate hedging and speculation. A risk averse manager represents a firm that is priced in a risk neutral competitive market. The manager enters into a cash flow hedge of a forecast transaction and chooses a futures position based on private information. As the futures position is to be disclosed, the market uses this
information to infer the manager’s private knowledge and incorporates its inferences into prices. This may create a managerial incentive to “overhedge”, that is to take a speculative position.

In the basic setting the manager speculates whenever he prefers higher first period firm values to lower ones and enters into a partial hedge if the opposite is true. Adding transaction costs we find that speculation becomes less beneficial and (partial) hedges are more likely to be observed. If uncertainty w.r.t. the manager’s preferences is included into the model, managerial incentives to speculate and to hedge are preserved even though they are mitigated compared to the basic setting.

Our results are obtained in an asymmetric information environment that is likely to occur and in the presence of reporting requirements that comply with present accounting rules. These reporting requirements are quite general in the sense that we only claim that the derivatives market position is truthfully conveyed in the financial statements. This may hold in the context of hedge accounting and just as well if general accounting rules for financial instruments are applied. Accordingly, no accounting bias or misstatement is required for the results to hold.

Apart from providing some insights into incentives for corporate speculation and hedging our findings are of particular concern from a standard setting perspective. They indicate that additional disclosure requirements are not necessarily suitable to prevent or even reduce adverse activities like speculation. Moreover, in our setting disclosure requirements create incentives for the firms’ managers to speculate or to perform suboptimal hedges, that were absent without such requirements. Concurrently, we find that the market correctly infers private information at least on average. Potential investors are therefore neither fooled nor harmed. Nonetheless, the inefficient equilibria that arise, reduce overall welfare. Depending
on the distribution of bargaining power either the manager or the actual owners are to pay the price. Whether our results should be interpreted as an argument for less detailed disclosure in financial statements boils down to the question who is effectively harmed and which users of financial statements standard setting bodies wish to serve best.
Appendix A:

Details on computation of (5):

The market price \( P_2 \) at \( t = 1 \) given that the manager has observed \( y \) is a random variable:

\[
P_2 = (\mu_p + \eta)(y + \varepsilon_2 - (y + b)) + \mu_p(y + b) = \mu_p \cdot \varepsilon_2 + \eta \cdot \varepsilon_2 + \mu_p y - \eta b
\]

\[
\text{Var}(P_2|y) = \text{Var}(\mu_p \cdot \varepsilon_2 + \eta \cdot \varepsilon_2 - \eta b)
\]

\[
= \mu_p^2 \text{Var}(\varepsilon_2) + \text{Var}(\eta \cdot \varepsilon_2) + b^2 \text{Var}(\eta) + 2 \mu_p \text{Cov}(\varepsilon_2, \eta \cdot \varepsilon_2) - 2 \mu_p \text{Cov}(\varepsilon_2, \eta) - 2b \text{Cov}(\eta \cdot \varepsilon_2, \eta)
\]

as

\[
\text{Var}(\eta \cdot \varepsilon_2) = \text{Var}(\eta) \cdot \text{Var}(\varepsilon_2)
\]

and

\[
\text{Cov}(\varepsilon_2, \eta \cdot \varepsilon_2) = \text{Cov}(\varepsilon_2, \eta) = \text{Cov}(\eta \cdot \varepsilon_2, \eta) = 0
\]

we obtain (5):

\[
\text{Var}(P_2|y) = \mu_p^2 \text{Var}(\varepsilon_2) + \text{Var}(\eta) \cdot \text{Var}(\varepsilon_2) + b^2 \text{Var}(\eta) = \mu_p^2 \sigma_\varepsilon^2 + \sigma_\eta^2 \sigma_\varepsilon^2 + b^2 \sigma_\eta^2
\]

Details on computation of (18):

\[
E(x|z, \hat{b}) = \mu_x + \frac{\text{Cov}(x, z)}{\sigma_z^2}(z - E(z))
\]

as \( z = y + \hat{b} \) and \( b \) is a constant we get:

\[
E(z) = E(y) + \hat{b} = \mu_y + \hat{b} \quad \text{and} \quad \text{Var}(z) = \text{Var}(y) = \sigma_y^2, \text{Cov}(x, z) = \sigma_x^2
\]

it follows that

\[
E(x|z, \hat{b}) = \mu_x + \frac{\sigma_x^2}{\sigma_z^2}(z - \mu_x - \hat{b}) = z - \hat{b}
\]

Details on computation of (18b):

\[
E(x|z, \hat{b}_w) = \mu_x + \frac{\text{Cov}(x, z)}{\sigma_z^2}(z - E(z))
\]
with \( E(z) = E(y + \hat{b}_w) = E(y) + E(\hat{b}_w), \ E(\hat{b}_w) = \hat{\delta}E(w) = \hat{\delta}\mu_w, \)

\[ \text{Var}(z) = \text{Var}(y) + \hat{\delta}^2\text{Var}(w) = \sigma_1^2 + \hat{\delta}^2\sigma_w^2, \]

\[ \text{Cov}(x, z) = \text{Cov}(\varepsilon_1 + \varepsilon_2, \varepsilon_1 + \hat{\delta}w) = \text{Var}(\varepsilon_1) = \sigma_1^2 \]

inserting we get

\[ E(x \mid z, \hat{b}_w) = \mu_x + \frac{\sigma_1^2}{\sigma_1^2 + \hat{\delta}^2\sigma_w^2} (z - \mu_x - \hat{\delta}\mu_w) \]

**Appendix B**

**Proof of proposition 3:**

(i) To prove that a unique linear equilibrium exists we need to show that unique solutions exist to all parameters in (12b) and (13b) \((\alpha, \beta, \gamma, \delta, \iota)\). We use the requirement that all conjectures are correct in equilibrium and replace them with the candidate equilibrium values.

From the previous analysis we obtained unique solutions for \(\gamma\) and \(\iota\) \((\gamma = 0\) and \(\iota = 0\)).

It remains to show that unique solutions exist for \(\alpha\), \(\beta\) and \(\delta\).

Inserting the candidate solution for \(\delta\) into the one for \(\alpha\) we obtain

\[ \alpha = \frac{\sigma_1^2}{\sigma_1^2 + (\frac{\mu_x}{r\sigma_\gamma})^2\sigma_w^2} \]

Rearranging terms yields the following equation:

\[ \alpha^3 (\frac{\mu_x}{r\sigma_\gamma})^2 + a\sigma_1^2 - \sigma_1^2 = 0 \]

\(A\) unique solution \(\bar{\alpha}\) to solve (B1) exists as the left hand side of the equation is strictly monotonic in \(\alpha\).
As $\delta$ in equilibrium is a unique function of $\alpha$, the solution for $\delta$ is unique, too. The same argument applies to $\beta(\alpha, \delta)$.

(iii) We use (B1) to prove that in equilibrium $0<\alpha<1$ and define

$$f(\alpha) = \alpha^3 \left( \frac{\mu p \sigma_w^2}{r \sigma_\eta} \right)^2 + \alpha \sigma_1^2 - \sigma_1^2.$$

$\left( \frac{\mu_p \sigma_w}{r \sigma_\eta} \right)^2$ and $\sigma_1^2$ are positive constants.

The proof is by contradiction:

If $\alpha \leq 0$ $f(\alpha) < 0$ and (B1) is not satisfied.

If $\alpha \geq 1$ $f(\alpha) > 0$ and (B1) is not satisfied.

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References


Figure 1: Timeline

\[ P_0 = \mu_p \mu_x \]

Manager learns \( y \)

Futures position chosen

\( R_1 \)
published

\[ P_1 = P_1(R_1) \]

\( p_x \)
realized,

Futures contract settled

\( R_2 \)
published

\[ P_2 = P_2(R_1, R_2) \]
Notes


2 Such as in Smith/Stulz (1985).


4 See IAS 32.51ff and SFAS 133.45 for details.

5 For details see IAS 32.58, IAS 39.88 and SFAS 133.20, SFAS 133.44f.

6 Note that our normal distribution assumption allows in principle for negative realizations of $p$ and $x$. As this is intuitively unreasonable we might assume that the respective means exceed the standard deviations by a large amount which implies that the probability of negative outcomes is arbitrary small. See Fischer/Verrecchia (2000, p. 231).

7 Thus a futures contract that fixes a selling price equal to the expected future spot price at delivery date has a fair price of zero.

8 Mean variance preferences can be derived endogenously if an individual has a negative exponential utility function and his welfare is normally distributed. While in this model all random variables are normally distributed, the manager’s welfare depends on the product of two random variables $p$ and $x$ which is not normally distributed. To keep the model tractable we exogenously assume mean variance preferences. For other papers making similar assumptions see Feltham/Wu (2001) or Melumad et al (1999). See also Christensen/Feltham (2003, p. 53) for a derivation of the mean-variance objective function as an approximation of the certainty equivalent using Taylor expansion.

9 This will be shown in detail in sections 3 and 4.

10 See e.g. Fischer/Verrecchia (2000, p. 233).

11 For further arguments see Fischer/Verrecchia (2000, p. 233) or Ewert/Wagenhofer (2005, p. 1105).

12 As only relative preferences matter in our model we implicitly attach a weight of unity to $P_x$. This does not affect our qualitative results.

13 For details see appendix A.


15 Details can be found in appendix A.

16 Certainly randomizing $w$ is only one possibility to feed uncertainty into the model we use, but doing so keeps the model simple and the results are descriptive. Also note that the assumption of $w$ being normally distributed allows for negative values for $w$, consistent with the assumptions made throughout the paper. If we would nonetheless restrict ourselves to a setting with $w > 0$, our results would approximate results of such a setting closely given that $E(w) > 0$ and $Var(w)$ sufficiently small. In that case the same argument as for $x$ and $p$ presented in footnote 6 applies.

17 We denote the position chosen by the manager in this section with uncertain preferences $b_m$.

18 For details see appendix A.