# Corporate Incentives for Hedging and Hedge Accounting

Peter M. DeMarzo; Darrell Duffie

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**Peter M. DeMarzo**
Northwestern University

**Darrell Duffie**
Stanford University

*This article explores the information effect of financial risk management. Financial hedging improves the informativeness of corporate earnings as a signal of management ability and project quality by eliminating extraneous noise. Managerial and shareholder incentives regarding information transmission may differ, however, leading to conflicts regarding an optimal hedging policy. We show that these incentives depend on the accounting information made available by the firm. Under some circumstances, if hedge transactions are not disclosed (i.e., firms report only aggregate earnings), managers hedge to achieve greater risk reduction than they would if full disclosure were required. In these cases, it is optimal for shareholders to request only aggregate accounting reports.*

Financial hedging, or "risk management," is an aspect of corporate financial policy that has received relatively little attention by economists. This is especially surprising given that the demand for such hedging by corporations is an important component of the explo-

sion in financial innovation that has occurred in the last decade. Currency and interest rate derivative markets, for example, are dominated by corporate trading. Moreover, the current growth in the market for over-the-counter derivative securities, such as swaps, is largely due to a corporate demand to hedge specific risks. Given the prevalence and importance of this type of activity, the underlying economic rationale for, and implications of, corporate hedging are important questions to be considered.

This article explores the use of financial hedging by managers motivated by career concerns. Our analysis demonstrates that the optimal hedging policy adopted by managers depends on the type of accounting information made available to shareholders. This connection sheds light on why managers often hedge accounting risk as opposed to, or in addition to, economic risk. Casual observation suggests that managers are concerned with the accounting consequences of their hedging decisions, and that in fact these consequences may influence their choice of hedging instrument, or whether they hedge at all.

In addition, the connection between disclosure requirements and equilibrium hedging allows us to explore the consequences of alternative accounting standards on the value of the firm. In the context of our model, we show that even though the value of the firm is increasing in the amount of information available to shareholders, it can be optimal for shareholders to require *ex ante* that managers not disclose their hedging activities. These results are pertinent to the current debate on appropriate hedge accounting standards.

Much of the prior literature on hedging derives the optimal hedge positions of a risk-averse manager-owner whose stake in the firm is not fully diversified.[1] Another case in which hedging has been shown to increase firm value involves costs associated with financial distress or external financing, as well as convexities in the corporate tax code.[2] Finally, hedging may also alleviate suboptimal risk allocation resulting from an agency problem between managers and shareholders, thereby reducing agency costs.[3]

Our analysis differs from these approaches in a significant way. Rather than focus on the role of hedging in directly reallocating risk among parties, we stress the *informational effect* of hedging. Hedging reduces the amount of "noise" and increases the informational

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[1] See, e.g., Holthausen (1979), Anderson and Danthine (1981); and Stulz (1984). DeMarzo and Duffie (1991) demonstrate optimal hedging policies by firms on behalf of risk-averse shareholders when firms have proprietary information about their risk exposure.

[2] See Smith and Stulz (1985). Also, Froot, Scharfstein, and Stein (1993) focus on costly external financing and explore the interaction of hedging and investment policy.

[3] See Campbell and Kracaw (1987) and DeMarzo and Duffie (1992).

content in the firm's profits. This informational effect can have real consesquences even if all agents are risk neutral. In fact, we identify in our model two natural and important channels for this informational effect: (1) the quality of the information received by shareholders affects the value of their "option" to continue or abandon the investment project, and (2) the information revealed by profits typically has a nonlinear effect on the reputation, and hence future wages, of the current managers.

The informational effect of hedging may explain why some firms have adopted a decentralized risk-management policy in which each division or "profit center" is allowed to hedge its financial risk independently. Most of the alternative justifications for hedging would predict a centralized approach in order to minimize costs. While centralized hedging is not inconsistent with our approach, our model also demonstrates that decentralized hedging may have the advantage of increasing the informativeness of divisional performance reports, thereby enhancing the firm's ability to allocate resources internally. (In practice, some firms net these decentralized hedges internally before external transactions are executed.)

Our basic model is as follows. We extend the model of Holmstrom and Ricart i Costa (1986) and consider an environment in which uncertainty regarding managerial ability and project profitability implies that shareholders learn about the quality of the firm's management and investment projects from observations of the firm's performance. This learning links current profits with a manager's reputation and future wages. Furthermore, by hedging pricing fluctuations, managers can alter the risk of the firm's current profits, which in turn affects the risk of their future wages. Managers' preferences regarding their future income can thus provide a motive for financial hedging.

Of course, the logic of the Modigliani-Miller (1958) irrelevance results holds in this setting in the absence of asymmetric information.[4] We assume that managers and shareholders are equally informed about managerial ability (managers are also learning about their ability), so that hedging policy cannot itself serve as a signal of management quality. Instead, we make the realistic assumption that managers are better informed about the source and magnitude of the risks the firm faces. For example, managers may have better and more current information regarding the foreign exchange, interest rate, or commodity price exposure of the firm. This asymmetry naturally puts management in a better position to hedge these risks.

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[4] See, e.g., DeMarzo (1988) for an extension of the MM results to corporate trading of arbitrary financial securities.

There is another potential source of asymmetric information that distinguishes hedging decisions from most other aspects of corporate financial policy. Unlike dividends or capital restructurings, hedging positions may not be publicly disclosed or may only be partially disclosed. This issue of disclosure versus nondisclosure of hedging positions can be interpreted as a choice of accounting standards. Roughly speaking, corporations can choose whether to report hedging profits and losses separately from production profits, or to report only aggregate profits by combining these accounts (see Section 2 for a more extensive discussion of these standards).

In this setting, we demonstrate the following principal results. With nondisclosure of hedging activity, risk minimization (full hedging) is an equilibrium policy for managers. If full disclosure of hedging positions is required, however, this equilibrium is typically destroyed. In fact, the most natural equilibrium in this setting is for managers not to engage in hedging at all.

The intuition for our results stems from the fact that hedging reduces the risk of the firm's profits. Holding fixed the inferences made by shareholders about managerial ability given the firm's performance, reduced profit variability implies reduced wage variability, which benefits risk averse managers. With nondisclosure of hedging, reduced wage variability is the only effect, and full hedging is the natural equilibrium.

If hedging positions are disclosed, however, a second effect of hedging becomes important. Hedging eliminates a source of noise from the firm's profits, making profits a more informative signal of managerial quality. Thus, shareholder perceptions of managerial ability are more sensitive to the firm's performance if hedging is undertaken. Holding fixed the variability of profits, this implies that managerial wages may become more variable. The second effect is to the detriment of risk averse managers, and in fact destroys the incentive for full hedging.

In the final section of the article we explore the impact of these alternative scenarios on the value of the firm. In our model, because the firm has the option to continue or abandon the project, better information regarding project quality improves the value of the firm by allowing shareholders to exercise their option more efficiently. Thus, the shareholders have an incentive *ex post* to observe all information relevant to the firm. In general, this would include disaggregated accounts distinguishing production profits from hedging profits (or losses). As argued above, however, such a disclosure rule might prevent managers from engaging in effective hedging. In fact, we show that in certain cases, it may be optimal for shareholders to commit *ex ante* to requiring only aggregate hedge accounts, since in that case

managers do engage in full hedging, increasing the quality of the information that shareholders receive.

## 1. Hedge Accounting Standards

Because our results are sensitive to the type of information that is revealed to shareholders, we begin with a brief description of some of the existing accounting standards for hedging activity. We note, however, that in the United States these standards are the subject of significant debate and are currently being reviewed and revised; they are thus likely to change in the near future.

In the United States, the Financial Accounting Standards Board (FASB) and other regulatory and quasi-regulatory agencies set standards for the accounting of futures contract positions and other hedging positions such as forwards and options. These standards are generally accepted accounting procedures[5] (GAAP), and have a significant impact on the information about hedging positions and revenues that reach shareholders of publicly traded corporations. Treatment of hedge accounting in some non-U.S. jurisdictions (such as the United Kingdom) is similar in spirit.

There are two basic approaches to the accounting treatment of derivative securities, "mark-to-market" and "hedge" accounting. Under mark-to-market accounting, changes in market value show up, as they occur, in earnings.[6] Hedge accounting refers to a general method of accounting, usually for both income statement and balance sheet, for a financial instrument used to control the risk associated with changes in prices or interest rates. Under certain hedge accounting criteria, the gains and losses on the hedging instrument are not brought into the income statement and balance sheet until the time at which the gains or losses associated with the hedged exposure are also recorded.[7]

The logical basis for hedge accounting is that the hedging instrument, if indeed a *bona fide* hedge, should not have an accounting life of its own, but rather should be considered as part of a unified package: commitment plus hedge. For example, if a commitment to purchase copper for a wire manufacturer is hedged with a copper

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[5] The SEC requires the use of generally accepted accounting procedures for registered public corporations, and in some cases, actually regulates GAAP directly.

[6] There are some exceptions. For example, a portion of profits is sometimes deferred and amortized to act as an accounting buffer against default and operational costs.

[7] In some cases, the hedged exposure is itself marked to market with each accounting statement, in which case there is in fact no deferral of marks to market on the hedge. In other cases, the item to be hedged is only accounted for with delay, as is usually the case, for example, with a commitment to buy or sell some item at a future time. In the latter case, profits or losses on the hedge are sometimes amortized, and therefore appear in the accounts of the firm with a lag.

futures position, then a loss on the futures position should not be construed as a negative accounting event, given that the commitment to purchase copper does not itself appear in the accounts.

## 1.1 Disclosure of derivative positions

In addition to accounting treatments for income statements and balance sheet, the FASB stipulates that financial statements provide supplementary notes disclosing information regarding the objectives, risks, and in some cases the gains and losses, of derivative positions. These rules have recently been revised as amendments to Statements of Financial Accounting Standards (SFAS) 105 and SFAS 107 published in October 1994 in the form of SFAS 119, "Disclosure About Derivative Financial Instruments and Fair Value of Financial Instruments." SFAS 119 mandates significantly more disclosure for off-balance sheet instruments, including many derivatives such as futures, forwards, and swaps. SFAS 119 also makes a distinction between positions taken for hedging and for other purposes. For positions that qualify for hedge accounting, verbal descriptions of the objectives of the positions and the methodology used for reporting purposes must be provided. At this stage, FASB standards still do not stipulate disclosure of quantitative information regarding the extent of price risk associated with derivative positions; however, the U.S. Securities and Exchange Commission proposes to do so. As reported in the *Wall Street Journal:*[8]

> Companies are already required by the FASB to disclose the risk of derivatives that they buy to trade or speculate in financial markets. The SEC proposal would expand disclosure rules to derivatives that are used to hedge, or offset risk, in such things as currencies, commodities, and interest rates. Although such derivatives can be less risky, the SEC believes that the potential losses on such contracts should still be disclosed to investors.

As the first financial statements to appear under SFAS 119 have yet to be released, the degree of detail in the disclosures made under SFAS 119 that will be viewed as appropriate by major accounting firms remains unclear. There is also a practical question of the informational "weight" accorded by investors to supplementary notes relative to income statements and balance sheets (an issue that seems difficult to model). The disclosure required under SFAS 119 goes beyond that required in most other jurisdictions. Our model may therefore have some predictive implications for hedging activity by U.S. firms relative to non-U.S. firms.

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[8] See the *Wall Street Journal,* January 17, 1995, page A2.

Separate hedge accounting reports are sometimes required by special regulation, for example, in certain cases involving the banking and brokerage industries. In principle, the managers of a firm could, even if not required by GAAP, publish separate accounts of profits and losses on those hedges qualifying for hedge accounting. In practice, the authors' casual but persistent inquiries indicate that this kind of discretionary reporting is uncommon.[9]

### 1.2 Hedge accounting criteria

Since the potential for delaying profits or losses could, with sufficient flexibility in the rules for hedge accounting, provide an incentive for manipulation of the information reaching shareholders and the marketplace, these rules usually have narrowly defined criteria. In the United States, the two basic GAAP standards are SFAS 52 and SFAS 80. SFAS 80 treats futures, except for foreign currency translation, while SFAS 52 treats foreign currency translation, and in principle takes precedence for foreign currency derivatives.

The SFAS 80 criteria for hedge accounting are

1. The item to be hedged must expose the transacting enterprise to financial risk.
2. The hedging position must be designated, at the inception of the position, as a hedge and must reduce the enterprise's exposure to risk.
3. The significant characteristics and expected terms of the anticipated transaction must be identified.
4. It is probable that the anticipated transaction will occur.

The second criterion is significant in two regards. First, the "designation" requirement is designed to eliminate the option of according hedge accounting or not, *after* the profitability of the derivative position is known. On the other hand, the designation rule is particularly notable in the context of this paper, as it effectively gives an *ex ante* option to the managers of the firm to use hedge accounting or not on a case-by-case basis. If there is no designation, the derivative position is not accorded hedge accounting.

Second, the phrase "must reduce the enterprise's exposure to risk" is interpreted as requiring a sufficiently high correlation of changes in value of the hedge and the item hedged, and as requiring that a reduction in the risk associated with this position is in fact a reduction

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[9] Of course, nondisclosure of material risk might expose the firm to "fraud-on-the-market" lawsuits.

in the overall financial risk of the firm.[10] Note also that discretion in the use of hedge accounting treatment can also be obtained by exploiting this requirement of "correlation." For example, at perhaps some cost in hedging efficiency, managers could opt to hedge with a derivative instrument that does not pass a threshold test of correlation in order to avoid hedge accounting treatment.[11]

For foreign currency related hedging positions, SFAS 52 is significantly more restrictive than SFAS 80 in its treatment of anticipated foreign revenue. Specifically, SFAS 52 allows sales revenue to qualify for hedge accounting only to the extent of signed commitments. This treatment of anticipated foreign revenue is widely felt to be overly restrictive, as foreign revenues can be reliable, and represent a substantive risk to the firm, yet nevertheless not be firmly contracted sufficiently in advance to obtain significant hedge accounting coverage.[12] SFAS 52 was written before foreign currency options became active hedging instruments, and does not specifically cover these options. The de facto treatment of options has therefore come to be more in the spirit of SFAS 80, which was designed mainly for futures. This approach has recently been adopted for hedges with put options of anticipated foreign revenues by the Emerging Issues Task Force (EITF) in its March 19, 1991, meeting. (EITF consensus decisions are treated as GAAP.) There are still, nevertheless, significant restrictions on the application of EITF 90-17 to derivatives hedging foreign currency revenues. For example, the Securities and Exchange Commission (SEC) effectively ruled out hedge accounting for publicly traded firms under EITF 90-17 for other than plain "vanilla" options, and (despite the spirit of SFAS 80 that otherwise underlies EITF 90-17) rules out the use of hedge accounting for options on one currency used as hedges for revenues in another currency, whether there is high correlation or not. (See also EITF 91-4 [Nov. 7, 1991] for further guidelines on the accounting treatment of other than plain vanilla options, including deep-in-the-money options.)

The ability to obtain foreign currency hedges with or without hedge accounting treatment is clearly available from the choice of whether to use forwards or options, whether to use exotic or plain vanilla options, whether to use hedges in the "target" currency or in proxy

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[10] These need not be equivalent. For example, a firm holding assets and liabilities with offsetting exposures could increase financial risk by selectively "hedging" one of the exposures.

[11] It may be interesting to study the question of which individuals or groups within the firm would make the decision to designate or not, that is, to opt or not, for hedge accounting treatment. Our model treats the management of the firm as a single player.

[12] See, for example, the description by Lewent and Kearney (1990) of foreign pharmaceutical revenue hedging, and hedge accounting, by Merck and Company.

currencies with high correlation, and so on. For economic hedging purposes, similar risk reduction can often be obtained whether one opts for hedge accounting or not, especially given the opportunity to synthetically create one form of hedge out of another by dynamic trading strategies or with specially designed derivative securities, with only minor accounting implications.

The accounting treatment for options (not covered under EITF 90-17) and for synthetic instruments, such as option-embedded bonds and interest rate swaps, is somewhat arcane, and remains to be sorted out along logical lines. Hedge accounting standards outside the United States are similar to the U.S. GAAP, although they tend to be less comprehensive and detailed.[13] For example, the British Bankers Association's "Statement of Recommended Practice" on "off-balance-sheet instruments, other commitments, and contingent liabilities" is similar to SFAS 80 in its criteria for hedge accounting treatment.

Hedge accounting and discretionary reporting of hedging revenue play an important role in our analysis. In some cases, our results show that there are clear incentives for managers or shareholders to have the firm's accounts show, or not show, separate information on hedging revenue. This raises incentive and corporate governance issues that remain somewhat puzzling, at least to the authors. A larger issue is the incentive to create quasi-regulatory bodies such as FASB to set GAAP. An "equilibrium" model of GAAP standard setting is well beyond the scope of our study.

For additional details on hedge accounting practice, see Beaver (1980), Bierman (1990), Herz (1994), and Stewart (1989).

## 2. The Setup

### 2.1 Production technology

There are two periods. The firm's total profit in the first period in the absence of hedging is $X + \theta\varepsilon$, where $X$, $\theta$, and $\varepsilon$ are independent random variables[14] and $X$ may be correlated with the manager's ability. Prior to the realization of $X$ and $\varepsilon$, the manager learns the level $\theta$ of exposure of the firm to the risk $\varepsilon$. We think of $\varepsilon$ as corresponding to fluctuations in exchange rates, interest rates, or commodity prices. A financial hedging contract, say a futures contract, is available to hedge this risk to some extent. This contract has a net payoff $Z$ in the following period, where $Z$ is independent of $X$ and $\theta$, and $E(Z) = 0$

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[13] See "The J. P. Morgan/Arthur Andersen Guide to Corporate Exposure Management," published by Risk Magazine, 1994.

[14] All random variables in the model are on some fixed probability space $(\Omega, \mathcal{F}, \mathcal{P})$.

(which is implied by our assumption of risk-neutral investors). After the manager learns $\theta$ and chooses a position $\phi$ in the futures contract on the firm's account, the firm has a total payoff including hedging of $Y = X + \theta\varepsilon + \phi Z$.[15]

To make hedging meaningful, the futures payoff $Z$ is chosen to be correlated with the risk $\varepsilon$. For example, $\varepsilon$ may correspond to a foreign currency exposure of the firm and $Z$ a "nearby" futures contract. Letting $\varepsilon = c + \beta Z + \eta$ be the linear regression of $\varepsilon$ on $Z$, we assume that $\beta \neq 0$. Thus a simple rescaling allows us to take $\beta = 1$. Also, in order to focus on the case in which the manager's private information concerns the risk of the firm and not the expected level of earnings, we assume $E(\varepsilon) = c = 0$. In sum, $\varepsilon = Z + \eta$, where $\eta$ is interpreted as the independent "basis risk" of the contract.

As stated in the Introduction, the profit component $X$ depends upon the manager's inherent ability as well as the intrinsic quality of the project. In particular, we take $X = a + e + m$, where $a$ corresponds to managerial ability, $e$ represents project quality, and $m$ is a production "shock" unrelated to ability or quality, and is unhedgeable using available securities. Formally speaking, we assume that $(a, e, m, Z, \eta)$ are jointly independent, though this assumption could be relaxed and is mainly for notational simplicity. It is also convenient (and without loss of generality) for us to normalize to the case of $E[X] = E[a] = 0$.

## 2.2 Wages and investment

In order to capture the relationship between managerial wages and past performance, we utilize a simple model of career concerns similar to that of Holmstrom and Ricart i Costa (1986). In this model, long-term labor contracts are not available, so the manager's future wage is determined in a competitive market for managerial services in the second period. In particular, we suppose that firms can offer only short-term fixed-wage contracts, which are then renegotiated each period.[16] We assume that in the second period there are several firms with an equivalent production technology to that of period 1. These firms compete for the manager's services in period 2 after learning something about the manager's ability from the first period profit $Y$

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[15] Both $\varepsilon$ and $Z$ are of finite variance. All of $X$, $\theta\varepsilon$, and $\phi Z$ are random variables with finite expectations.

[16] The assumption of fixed-wage contracts is, of course, restrictive. In our setting, the first-best contract would have the firm insure the manager against future reputation effects via a long-term or contingent contract. In practice, actual contracts are necessarily incomplete because of the manager's option to quit the firm (even with a long-term contract) and the manager's limited initial wealth (which prevents sufficient bonding). Given some degree of incompleteness, the information and reputation effects of hedging which we document will be important. Our assumption of fixed-wage contracts allows us to explore these effects in a relatively simple and tractable setting.

and other public data revealed during period 1. Each firm can either make an offer to the experienced manager, or hire a rookie manager for known wage $R$. Thus, the equilibrium wage for the manager in the second period is given by

$$W = R + E_1[Y_2(\text{experienced}) - Y_2(\text{rookie})] = R + E_1[a] - \bar{a} \quad (1)$$

where $\bar{a}$ is the average ability of rookie managers and $E_1$ represents expectation conditional on the information available at the end of the first period. Typically, this will include the observed first period profit of the firm, securities payoffs, and any additional publicly known information.[17] Because the constant component of the wage schedule plays no role in our analysis, we let $R - \bar{a} = 0$.

The firm's second-period investment decision is also tied to first-period performance. The firm can either continue its initial project, or abandon the project and choose a new one from a pool of available investment opportunities. Thus, the firm will continue the project if and only if $E_1[Y_2(\text{continue})] \geq E_1[Y_2(\text{abandon})]$. If we assume that project quality is independent, while managerial ability is equally productive across investments, then the firm continues the project if and only if $E_1[e] - \bar{e} \geq 0$, where $\bar{e}$ is the expected quality of the next best alternative project.[18] Because the firm holds the "option" to continue or abandon the project, its expected profits in the second period are therefore equal to

$$V = \max(E_1[e] - \bar{e}, 0). \quad (2)$$

### 2.3 Equilibrium

The equilibrium notion we use to analyze this model is the Bayesian-Nash Equilibrium.[19] Roughly speaking, such an equlibrium corresponds to a hedging policy $\phi$ (which may depend on $\theta$) for the manager, and a second-period wage function $F$ based on publicly available information. In equilibrium the hedge position $\phi$ is optimal for a manager who has observed the risk exposure $\theta$ and anticipates

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[17] The wage schedule (1) reflects the fact that competition between firms allows the manager to capture all the rents associated with general (transferable) ability. On the other hand, if competition were not perfect (due to switching costs or firm-specific human capital), these rents would be shared by the manager and the initial employer. Such a generalization will not affect our results as long as the initial employer holds all the bargaining power, and so can retain the manager by matching his/her best outside offer.

[18] Fixed costs of initiating projects could easily be incorporated and would reduce the minimal quality necessary to continue the project.

[19] This coincides with sequential and other refinements of Nash equilibrium when the observable random variables have full support (the typical case we consider), since then Bayes' rule can be used to update beliefs after any profit outcome.

the wage $F(\cdot)$. Moreover, given the hedging policy of the manager, $F$ is equal to the wage $W$ defined by Equation (1).

To make this definition precise, we must specify the set of public information at time 1. In addition to the firm's first-period profit $Y$, the other potential publicly observable variables are the risk exposure $\theta$, the futures position $\phi$, and the futures payoff $Z$. Thus we can specify the (exogenous) information structure via a function $S(Y, \theta, \phi, Z)$ generating the public information. For example, if the risk exposure of the firm is not observable, but the hedge portfolio and futures payoff are, then $S(Y, \theta, \phi, Z) = (Y, \phi, Z)$. (For convenience we will denote by $S$ the random variable $S(Y, \theta, \phi, Z)$.)

As mentioned above, the manager takes the wage function $F$ as given. The manager observes the risk exposure $\theta$, and so faces a family of problems, one for each possible outcome $\bar{\theta}$ of $\theta$. Given $\bar{\theta}$ and some candidate hedging position $\bar{\phi}$, the manager anticipates the random wage $F[S(X + \bar{\theta}\varepsilon + \bar{\phi}Z, \bar{\theta}, \bar{\phi}, Z)]$. We suppose that the manager maximizes the expected utility of this wage, with a strictly monotonic von Neumann-Morgenstern utility function $u$ having a bounded (and measurable) derivative. The set $\Phi$ of candidate hedging positions consists of those random variables that are independent of $\{X, a, e, \varepsilon, Z\}$ (since these are unknown to the manager when $\phi$ is chosen). The manager thus solves

$$\sup_{\phi \in \Phi} E[u(F[S(X + \theta\varepsilon + \phi Z, \theta, \phi, Z)]) \mid \theta]. \tag{3}$$

Naturally, Equation (3) is solved state by state, based on the outcome of $\theta$.

An equilibrium for $(u, a, e, m, \theta, \varepsilon, Z, S)$ is defined as a pair $(\phi, F)$, where $F$ is a wage formula satisfying $F(S) = E[a \mid S]$ almost surely,[20] and $\phi$ solves Equation (3) almost surely.

We assume throughout that the manager is risk averse, meaning that $u$ is concave. We sometimes consider the case of strict risk aversion, in which case $u$ is assumed to be strictly concave. Note that (strict) risk aversion implies that the manager (strictly) prefers wage $W_1$ to wage $W_2$ whenever $W_2$ is a mean-preserving spread of $W_1$.[21] Almost all of the results in this article rely solely on such comparisons, and so hold even in a framework of nonexpected utility.[22]

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[20] In many of the cases that we consider $S$ has full support, so that this condition defines $F$ almost everywhere.

[21] We define $W_2$ to be a mean-preserving spread of $W_1$ if there is a set $I$ of random variables such that $W_1$ is equivalent in distribution to $E[W_2 \mid I]$. See Rothschild and Stiglitz (1970).

[22] Machina (1982) and others following him have presented examples in which the assumption of von Neumann-Morgenstern utility plays no role in exploiting the assumption of risk aversion; that is, a preference in favor of eliminating mean-preserving spreads.

## 3. Equilibrium Hedging

We now examine, in turn, equilibrium for three informational cases: (1) public knowledge of both the risk exposure and the hedging position, (2) public knowledge of the hedging position, but with the risk exposure known only to the manager, and finally (3) no public information on risk exposure or hedging position.

### 3.1 Public risk exposure and public hedging position

We begin with the obvious result that hedging is irrelevant if shareholders learn the hedging position and risk exposure before they make their wage offer in the second period.

**Proposition 1.** *Suppose that* $S(Y, \theta, \phi, Z) = (Y, \theta, \phi, Z)$. *Then any hedging decision* $\phi$ *is consistent with an equilibrium, and the equilibrium wage* $W$ *and value* $V$ *to the firm are invariant to the choice of* $\phi$.

*Proof.* Fix any hedging decision $\phi$. Because of our independence assumptions,

$$E[a \mid S] = E[a \mid X + \theta\varepsilon + \phi Z, \theta, \phi, Z] = E[a \mid X + \theta\varepsilon, \theta, Z],$$

which shows that the equilibrium wage does not depend on $\phi$. As for $V$, again because of the informational assumptions, a similar calculation holds for the distribution of $e$ given $S$. ∎

This result contrasts with the corresponding result for a capital-investment decision with unreported return $Z$ to scale. This is a case in which $S(Y, \theta, \phi, Z) = (Y, \theta, \phi)$. In fact, in this case risk-averse managers may have an incentive to "antihedge" and thereby garble the information received by the market. By reducing the informativeness of the firm's profits for managerial ability, such garbling would lower the sensitivity of the manager's future wage to these profits. If this lower sensitivity of the wage function more than compensates for the increased risk in profits, the net effect would be to reduce the risk in the manager's wage and increase utility.

Though it might seem that the total effect of antihedging is ambiguous, the following result demonstrates under natural assumptions that garbling does in fact decrease the risk faced by the manager.

**Proposition 2.** *Suppose the manager is strictly risk averse and* $S(Y, \theta, \phi, Z) = (Y, \theta, \phi)$. *Then if* $(\varepsilon, Z)$ *are joint normal, the manager strictly prefers hedging position* $\hat{\phi}$ *to* $\phi$ *if and only if* $(\theta + \hat{\phi})^2 > (\theta + \phi)^2$.

*Proof.* If $S = (Y, \theta, \phi)$, then given $S$ the manager receives the wage $E[a \mid X + \theta\varepsilon + \phi Z, \theta, \phi]$. Suppose $(\theta + \hat{\phi})^2 > (\theta + \phi)^2$. Given $\varepsilon = Z + \eta$,

joint normality implies that $(a, X + \theta\varepsilon + \hat{\phi}Z)$ is identically distributed with $(a, X + \theta\varepsilon + \phi Z + v)$, where $v$ is an independent normal random variable with mean zero and variance $[(\theta + \hat{\phi})^2 - (\theta + \phi)^2] \text{var}(Z)$. Therefore,

$$E[a \mid X + \theta\varepsilon + \hat{\phi}Z] = E[a \mid X + \theta\varepsilon + \phi Z + v]$$
$$= E(E[a \mid X + \theta\varepsilon + \phi Z] \mid X + \theta\varepsilon + \phi Z + v)$$

so that the wage given position $\phi$ is a mean-preserving spread of the wage with position $\hat{\phi}$. ■

Thus there cannot be any equilibrium unless $\phi$ is arbitrarily bounded. Intuitively speaking, faced with this situation, the manager is interested in garbling the ability-related signal reaching the market so as to reduce the risk of the second-period wage. The more garbled the signal, the higher the manager's utility. This "signal jamming" result is common in models with reputation or career concerns. For example, Holmstrom and Ricart i Costa (1986) and Hirshleifer and Chordia (1991) demonstrate distortions in both the level and timing of real investment caused by reputational risk aversion.

These two propositions highlight an important distinction between financial policy, in which the manager chooses a public portfolio, and investment policy, in which the manager can choose the riskiness of a private investment. In the first case, the observability of the portfolio returns leads to an MM irrelevance result, while with real investment, the fact that the returns are not publicly observed implies that these decisions have real consequences.

### 3.2 Private risk exposure, public hedging position
In this section, we consider the case in which shareholders observe $S(Y, \theta, \phi, Z) = (Y, \phi, Z)$, but do not learn the risk exposure $\theta$ of the firm. A key assumption of the Modigiliani-Miller irrelevance result does not apply since managers have better information than do outsiders regarding $\theta$. It is not clear, however, that hedging should have any important effect in this case, since shareholders observe $\phi Z$ and can therefore disentangle production profits from hedging profits. In fact, as we now show, hedging has no effect if it is independent of, and hence uninformative about, the risk exposure $\theta$. This includes, for example, the case of no hedging ($\phi = 0$).

***Proposition 3.*** *Suppose $S(Y, \theta, \phi, Z) = (Y, \phi, Z)$. Then there is an equilibrium for any ineffective hedging position, that is, for any $\phi$ that is independently distributed of the risk-exposure $\theta$. In this equilibrium, the manager's wage and the value of the firm's investment option do*

*not depend on $\phi$, and are given by $W = E[a \mid X + \theta\varepsilon, Z]$ and $V = \max(E[e \mid X + \theta\varepsilon, Z] - \bar{e}, 0)$.*

The proof of equilibrium is almost identical to that of Proposition 1. Of course, this is not necessarily the only possible equilibrium outcome. If the manager chooses $\phi$ in a way that depends on $\theta$, then $\phi$ becomes a "signal" of $\theta$ to the outside shareholders. That is, shareholders should use their knowledge of $\phi$ to make inferences about the risk exposure of the firm when determining their estimates of the manager's ability.

Though many such signaling equilibria may be possible, we are interested in the possibility of equilibria in which "maximal hedging" occurs. Given $\varepsilon = Z + \eta$, it is natural to define the equal and opposite hedging position $\phi = -\theta$ as a maximal hedging policy; any other hedge position $\tilde{\phi}$ would lead to profit $\tilde{Y}$ that is a mean-preserving spread of $Y$.

In this setting of public disclosure of the hedge position, shareholders can disentangle hedge profits from production profits. We next demonstrate that, because of this, the only relevant aspect of the chosen hedging policy is in fact its signaling potential. That is, maximal hedging in this context leads to exactly the same wage distribution as any other hedging policy from which shareholders can perfectly infer $\theta$. We say that the hedging policy $\phi$ is "invertible" if there is some function $\rho$ such that $\rho(\phi) = \theta$. Maximal hedging is obviously just one example of an invertible policy. The following proposition demonstrates that the equilibrium wage schedule depends on the manager's choice $\phi$ only indirectly through $\rho(\phi)$.

**Proposition 4.** *Let $S(Y, \theta, \phi, Z) = (Y, \phi, Z)$, and suppose $\phi$ is an invertible hedging policy. Define $G$ such that $G(X + \theta\eta, \theta) = E[a \mid X + \theta\eta, \theta]$ almost surely. If the manager observes risk exposure $\bar{\theta}$ and chooses the hedge position $\bar{\phi}$, then the manager's equilibrium wage is*

$$G(X + \bar{\theta}\eta + (\bar{\theta} - \rho(\bar{\phi}))Z, \rho(\bar{\phi})),$$

*where $\rho(\phi) = \theta$.*

*Proof.* Given $\rho(\phi) = \theta$

$$(Y - \phi Z - \rho(\phi)Z, \rho(\phi)) = (X + \theta\eta + (\theta - \rho(\phi))Z, \rho(\phi))$$
$$= (X + \theta\eta, \theta).$$

Therefore, $E[a \mid Y, \phi, Z] = E[a \mid X + \theta\eta, \theta, Y, \phi, Z] = E[a \mid X + \theta\eta, \theta]$. ∎

Thus, the manager's only concern in choosing a hedging policy $\phi$ is the inference that shareholders make regarding $\theta$. A maximal hedging

equilibrium can only exist, therefore, if it is in the manager's interest to reveal $\theta$ truthfully to shareholders. We believe, however, that such an equilibrium is unlikely. To see this, suppose that the manager deviates from a maximal hedging policy and after observing the risk exposure $\bar{\theta}$ chooses a hedging position $\hat{\phi} = -\bar{\theta} + \delta$. For $\delta$ small, this has no "first-order" impact on the variance of the firm's profits, but in general does have a first-order impact on shareholders' inferences about $\theta$, and hence on the wage schedule.

To make this intuition precise, note that in an equilibrium with $\rho(\phi) = \theta$, the manager chooses $\phi$ to maximize $E[u(G(X + \theta\eta + (\theta - \rho(\phi))Z, \rho(\phi)))]$. Because this expected utility depends on $\phi$ only through $\rho(\phi)$,

$$\bar{\theta} \in \operatorname*{argmax}_{\tilde{\theta}} E[u(G(X + \bar{\theta}\eta + (\bar{\theta} - \tilde{\theta})Z, \tilde{\theta}))],$$

for almost every $\bar{\theta}$. This is identical to the condition for an equilibrium in which the manager truthfully reveals $\theta$. For $\bar{\theta}$ in the interior of some interval contained by the support of $\theta$, this problem has the first-order necessary condition,

$$E[u'(G(X + \bar{\theta}\eta, \bar{\theta}))(-G_1 Z + G_2)] = 0,$$

where $G_1$ and $G_2$ denote the obvious partials evaluated at the obvious random variables. But since $E(Z) = 0$, independence implies that $E(u'G_1 Z) = 0$ (suppressing the arguments of $u'$ and $G_1$), and this condition reduces to

$$E[u'G_2] = 0. \tag{4}$$

Equation (4) involves only the underlying parameters of the model and is clearly nongeneric.[23] If Equation (4) does not hold for some outcome $\bar{\theta}$ of $\theta$ then the manager has an incentive to under- or overstate the firm's exposure in that case.

To illustrate this "signaling effect," we introduce two mild distributional assumptions that allow us to evaluate unambiguously this incentive to misreport.

**Assumption A.** *The distribution of $(a, X, \eta, Z)$ is symmetric about zero.[24] Also, $X + \theta\eta$ has a unimodal density.[25]*

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[23] One could consider, for example, perturbations in the utility function or the constant component of the wage schedule.

[24] By this, we mean that $(a, X, \eta, Z)$ and $(-a, -X, -\eta, -Z)$ are equivalent in distribution.

[25] We say that a random variable $X$ has a unimodal density if its density is nondecreasing for $x$ below some critical value $x^*$ and is nonincreasing for $x$ above $x^*$. Given the previous symmetry assumption, this assumption implies that $X+\theta\eta$ is unimodal around 0. A simple sufficient condition

**Assumption B.** *The maximal hedging wage schedule G defined in Proposition 4 has bounded, measurable first derivatives and $|G(Y, \theta)|$ is decreasing in $|\theta|$ for almost every Y.*

Assumption A is a simple symmetry condition, satisfied by the normal, uniform, and many other distributions. Assumption B is a natural monotonicity assumption. Increasing $|\theta|$ increases the variance of the "residual risk" $\theta\eta$, and so reduces the "signal-to-noise ratio" of $X + \theta\eta$. One would generally expect this to move the posterior estimate of the ability $a$ closer to its expected value (which is zero by assumption), or equivalently, reduce $|G(Y, \theta)|$. This condition is often naturally satisfied, as shown in the following examples.[26]

**Example 1.** *Suppose $(a, X, \eta)$ are joint normal. Then the wage schedule under maximal hedging, G, is given by*

$$G(Y, \theta) = \frac{\text{cov}(a, X)}{\text{var}(X) + \theta^2 \text{var}(\eta)} Y,$$

*which is decreasing in $\theta^2$.*

**Example 2.** *Suppose that a and e are symmetric binomial random variables with outcomes $\pm\frac{1}{2}$, that m and $\eta$ are standard normal, and that all are jointly independent. Figure 1 plots the wage schedule for $\theta = 1, 2,$ or 3.*

In each of these examples, notice that the wage schedule becomes less sensitive to output as the magnitude of the firm's exposure increases. This suggests that the manager has an incentive to misreport and overstate the magnitude of the firm's exposure as a means of reducing the risk of the future wage. Indeed, we can show

**Proposition 5.** *Let $S(Y, \theta, \phi, Z) = (Y, \phi, Z)$ and suppose that Assumptions A and B hold. Suppose that the support of $\theta$ contains an open interval, $\eta$ is nondegenerate, and the manager is strictly risk averse. Then any invertible hedging policy (for example, maximal hedging) cannot be a part of an equilibrium. In particular, the manager prefers to choose $\phi$ so as to overstate $|\theta|$ (i.e., such that $\rho(\phi)^2 > \theta^2$).*

*Proof.* Without loss of generality suppose that $\bar{\theta} > 0$. By symmetry and the strict concavity of $u$, whenever $G(y, \bar{\theta}) > 0$,

$$u'(G(y, \bar{\theta})) < u'(-G(y, \bar{\theta})) = u'(G(-y, \bar{\theta})).$$

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is that $X$ and $\eta$ are unimodal.

[26] In fact, we conjecture that Assumption B is implied by symmetry together with the Monotone Likelihood Ratio Property.
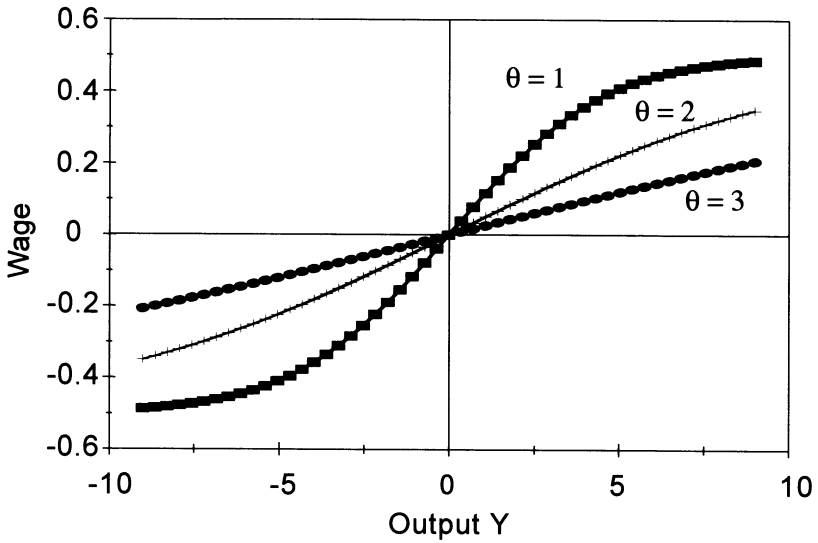
**Figure 1**
Wage schedule of Example 2.

By Assumption B, $|G|$ is decreasing in $|\bar{\theta}|$. Then by symmetry, $G_2(y, \bar{\theta})$ $= -G_2(-y, \bar{\theta}) < 0$ for $G(y, \bar{\theta}) > 0$. Therefore,

$$E[u'(G(X + \bar{\theta}\eta, \bar{\theta}))G_2(X + \bar{\theta}\eta, \bar{\theta}) \mid G(X + \bar{\theta}\eta, \bar{\theta}) > 0]$$
$$> -E[u'(G(-X - \bar{\theta}\eta, \bar{\theta}))G_2(-X - \bar{\theta}\eta, \bar{\theta}) \mid G(X + \bar{\theta}\eta, \bar{\theta}) > 0]$$
$$= -E[u'(G(X + \bar{\theta}\eta, \bar{\theta}))G_2(X + \bar{\theta}\eta, \bar{\theta}) \mid G(-X - \bar{\theta}\eta, \bar{\theta}) > 0]$$
$$= -E[u'(G(X + \bar{\theta}\eta, \bar{\theta}))G_2(X + \bar{\theta}\eta, \bar{\theta}) \mid G(X + \bar{\theta}\eta, \bar{\theta}) < 0],$$

which implies that $E(u'G_2) > 0$. Hence the agent would prefer some $\hat{\theta} > \bar{\theta} > 0$.  ∎

Again, the intuition of this result is that the manager prefers to exaggerate the risk exposure $\hat{\theta}$ that would be inferred by shareholders, since the increase in risk in the firm's profits is more than compensated for by the lower sensitivity of the wage schedule. Although this proposition is proved only for the symmetric case, we reiterate the fact that the nongenericity of Condition (4) implies that maximal hedging should not be expected in equilibrium when there is full disclosure of the hedging position.

### 3.3 No public information on risk exposure or hedging position

Finally, we take the case in which only the manager knows $\theta$ and $\phi$. This is the case that most closely corresponds in spirit to that treated by current FASB standards regarding hedge accounting. In this section we explore the consequences of this nondisclosure policy on equilibrium hedging behavior.

Our first result is that, in contrast with Proposition 5 of the previous section, maximal hedging is viable as an equilibrium hedging policy under hedge accounting. We verify this with the aid of the following weak assumption:

**Assumption C.** *Let G be the wage schedule under maximal hedging; that is, $G(X + \theta\eta) = E(a \mid X + \theta\eta)$ almost surely. Then G is strictly increasing.*

Assumption C is quite natural: High production profits should be "good news" about ability. Indeed, because $X + \theta\eta = a + e + m + \theta\eta$, a sufficient condition for Assumption C is that $e$, $m$, and $\theta\eta$ satisfy the Monotone Likelihood Ratio Property,[27] a property that is satisfied by most common distributions (see, e.g., Milgrom (1981)). This is, however, a somewhat more restrictive requirement on the term $\theta\eta$, since the product of independent random variables rarely corresponds to any "familiar" distribution.[28] The following example illustrates this assumption.

**Example 3.** *Let $(a, X, \eta)$ be distributed as in Example 1 or Example 2. Let $\theta$ be distributed on $[-k, k]$ with density*

$$f^\theta(\theta) \propto \theta^{-2} e^{-1/(2\theta^2)}.$$

*If $\eta$ is standard normal, then the product $\theta\eta$ has density*

$$f^{\theta\eta}(t) \propto (1 + t^2)^{-1} e^{-(1+t^2)/(2k^2)},$$

*which satisfies the MLRP for $k \leq 2$. Thus, Assumption C is satisfied. Figure 2 depicts the wage function for $k = 2$ and for $(a, X, \eta)$ as in Example 2.*

We now demonstrate that maximal hedging is indeed an equilibrium policy.

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[27] That is, the log of each density is concave.

[28] For example, the product of independent normals has a "spike" at zero, and so cannot be log-concave. On the other hand, given a standard distribution of $\eta$ satisfying the MLRP, it is easy to generate bounded random variables $\theta$ such that the product also satisfies the MLRP.
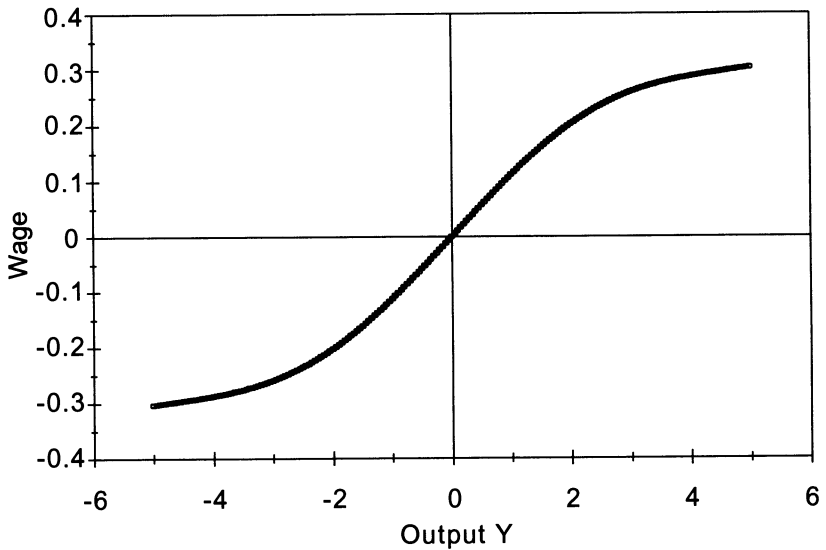
**Figure 2**
Wage schedule of Example 3.

**Proposition 6.** *Suppose $S(Y, \theta, \phi, Z) = (Y, Z)$ and that Assumptions A and C hold. Then maximal hedging ($\phi = -\theta$) is an equilibrium policy with associated wage $W = E(a \mid X + \theta\eta)$ and investment option value $V = \max(E[e \mid X + \theta\eta] - \bar{e}, 0)$. For this equilibrium, if the manager is strictly risk averse and $\text{var}(Z) \neq 0$, this is the unique optimal hedging policy for the manager.*

To prove this result, we first state the following useful technical lemma, which is proved in the appendix.

**Lemma.** *Suppose that $Y$ is symmetrically distributed with a unimodal density, that $Z$ is independent and symmetrically distributed with mean 0, and that $G$ is strictly monotone. If $|k| > |j|$ and if $E[G(Y + jZ)] \geq E[G(Y + kZ)]$, then $G(Y + jZ)$ second-order stochastically dominates $G(Y + kZ)$. Moreover, this dominance is strict if $Z$ is not degenerate.*

Roughly speaking, the lemma says that in the case of symmetric random variables, monotone functions preserve stochastic dominance. We now use this result to prove Proposition 6.

*Proof.* Under maximal hedging, $Y = X + \theta\eta$, so the equilibrium wage is

$$W = E(a \mid X + \theta\eta, Z) = E(a \mid X + \theta\eta) \equiv G(X + \theta\eta).$$

Assumption C implies that $G$ is strictly increasing. In addition, Assumption A implies that $X + \theta\eta$ and $Z$ are symmetrically distributed, and $X + \theta\eta$ is unimodal. This also implies that $E[a \mid -X - \theta\eta] = -E[a \mid X + \theta\eta]$, so that $G$ is odd. Therefore, $E[G(X + \theta\eta + kZ)] = E[G(X + \theta\eta)]$ for all $k$. Thus, we apply the lemma and learn that $G(X + \theta\eta + kZ)$ is more risky, in the sense of second-order stochastic dominance, than $G(X + \theta\eta)$. Given an outcome $\bar{\theta}$ for $\theta$, the manager thus (strictly) prefers the hedge $\bar{\phi} = -\bar{\theta}$, since any other hedge $\hat{\phi} = -\bar{\theta} + \delta$ generates profits $X + \theta\eta + \delta Z$. ∎

Though the proof of this result relies on the assumption of symmetry, this assumption can be relaxed. In fact, the symmetric case is in some sense a "knife-edge" case in that hedging only effects the risk of the wage. For nonsymmetric distributions, hedging will in general affect the expected value of the wage, thus creating strict incentives even for risk-neutral managers. The following example demonstrates that in the case of binomial ability, maximal hedging is a strictly optimal policy even for a risk-neutral manager, as long as the manager is *a priori* more likely to have high ability.

**Proposition 7.** *Suppose $S(Y, \theta, \phi, Z) = (Y, Z)$ and consider the binomial case of Example 3. Then maximal hedging is a strictly optimal equilibrium policy if* $\Pr\{a > 0\} > 1/2$.[29]

*Proof.* Under maximal hedging, if $a$ is binomial then the equilibrium wage equals $\alpha_1 \Pr\{a > 0 \mid X + \theta\eta\} - \alpha_2$, for constants $\alpha_1$ and $\alpha_2$. Given any prior probability $\pi$ that $a > 0$, let $p(X + \theta\eta, \pi) = \Pr\{a > 0 \mid X + \theta\eta\}$ almost surely. Then Bayes' rule implies that

$$\frac{p(y, \pi)}{1 - p(y, \pi)} = \frac{p(y, 1/2)}{1 - p(y, 1/2)} \frac{\pi}{1 - \pi}.$$

If $\pi > 1/2$, this implies that $p(\cdot, \pi)$ is a concavification of $p(\cdot, 1/2)$. In other words, the maximal hedging wage schedule with the asymmetric prior $\pi$ is a concave transformation of the symmetric wage schedule. This preserves (and in fact strengthens) the stochastic dominance argument used in the proof of Proposition 6. ∎

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[29] In addition, we can also show numerically that maximal hedging is a strict equilibrium if the distribution of project quality is skewed so that high-quality projects are relatively rare (as might be the case, e.g., with R&D).

Thus we have demonstrated that maximal hedging is indeed a robust equilibrium policy if managers do not report their hedge positions. One must interpret this result carefully, however, because any strategy that differs from maximal hedging by a known constant is still an equilibrium. That is, if $(\phi, F)$ is an equilibrium, then so is $(\hat{\phi}, \hat{F})$, where $\hat{\phi} = \phi + k$ and $\hat{F}(Y, Z) = F(Y - kZ, Z)$ for some constant $k$. Therefore, maximal hedging more appropriately defines an equivalence class of policies $\phi = -\theta + k$. This implies that in practice, "maximal hedging" is consistent with a policy of hedging only the difference between the firm's actual risk exposure and the exposure expected by investors.

Our next result demonstrates that in the case of perfect hedging, maximal hedging (up to translation by a constant) is in fact a weakly dominant strategy for the manager.

**Proposition 8.** *Suppose $S(Y, \theta, \phi, Z) = (Y, Z)$ and that $\eta = 0$. Then given any wage schedule F, if an optimal hedging policy for the manager exists, then there is an optimal policy of the form $\phi = -\theta + k$, where k is a constant.*

*Proof.* Given $\theta$, the manager chooses $\phi$ to maximize $E[u(G(X + \theta Z + \phi Z, Z)) \mid \theta]$. Letting $\phi = -\theta + \delta$, this is equivalent to choosing $\delta$ to maximize

$$E[u(G(X + \delta Z, Z)) \mid \theta] = E[u(G(X + \delta Z, Z))]. \tag{5}$$

Clearly, the solution to Equation (5) does not depend on $\theta$. Then if $k$ is any such solution, $\phi = -\theta + k$ is optimal for the manager. ∎

Thus, we argue that maximal hedging is a natural equilibrium in the absence of hedge reporting. In fact, in contrast with the case of separate hedge accounts, ineffective hedging (e.g., $\phi = 0$) is unlikely as an equilibrium. Such an equilibrium would require that Equation (5) have a continuum of maximizers, which appears nongeneric.

## 4. Reporting Incentives for Shareholders and Managers

We now focus on the incentives of the manager and shareholders to adopt an accounting system in which the hedge position $\phi$ is made public.

In our simple setting, shareholders have an incentive to obtain more precise information regarding the firm since this allows them to exercise their option to continue or abandon the current investment project. On the other hand, the manager has an incentive to obscure the information received by investors in order to reduce the

risk of his/her future wage. We formalize this as follows. Let $S$ be the information partition (or $\sigma$-algebra) associated with any set of publicly observable random variables, and define $W(S) = E[a \mid S]$ and $V(S) = \max(E[e \mid S] - \bar{e}, 0)$ to be the wage and investment option value given this information structure. Then we have,

**Proposition 9.** *If $S_1$ represents a coarser information structure than $S_2$ (that is, $S_1 \subset S_2$), then*

$$E[V(S_2)] \geq E[V(S_1)]$$

*and*

$$E[u(W(S_2))] \leq E[u(W(S_1))].$$

The result follows immediately from Jensen's Inequality and the convexity (concavity) of the firm's investment option (manager's utility). Moreover, the inequalities given by the proposition will be strict except in degenerate cases.

   Proposition 9 confirms that outside shareholders prefer equilibria in which the publicly available information regarding the firm is as precise as possible, and that such equilibria should lead to the highest initial value for the firm. Hence, it is tempting to conclude that shareholders should favor (and indeed require, if possible) a policy of full disclosure regarding hedging activities. That is, given the two possible informational settings

   1. $S = S_1 = (Y, Z)$ (no hedge reporting), and
   2. $S = S_2 = (Y, Z, \phi)$ (hedge reporting),

it would appear at first glance that $S_1 \subset S_2$ so that shareholders would prefer hedge reporting. This argument ignores, however, the equilibrium consequences of the firm's disclosure requirements on the distribution (and hence information content) of the firm's profits. To see the importance of this effect, consider the case of perfect hedging, in which $\varepsilon = Z$. With $S = S_2$ and the equilibrium with no effective hedging suggested by Proposition 3, we have

$$V(S_2) = \max(E[e \mid X + \theta\varepsilon, Z] - \bar{e}, 0) = V(X + \theta\varepsilon, Z)$$

   Alternatively, with $S = S_1$ (no hedge reporting) and the equilibrium with maximal hedging suggested by Proposition 6, we have

$$V(S_1) = \max(E[e \mid X] - \bar{e}, 0)$$
$$= \max(E[e \mid X, \theta, Z] - \bar{e}, 0) = V(X, \theta, Z)$$

It follows, therefore, that in this example $S_2 \subset S_1$, so that $V(S_1) >$

$V(S_2)$ and shareholders are in fact better off by requiring the firm to commit to an accounting system in which separate hedge accounts are not made available.

For the manager's part, the incentives are precisely the opposite. In the example described above the manager prefers to precommit to an accounting system in which hedges are reported, contrary to shareholders' wishes. If managers are "in the driver's seat" with respect to the choice of an accounting system, this example suggests that, in the presence of hedge accounting standards (such as SFAS 80) that effectively permit hedges to go unreported, managers may set up additional public accounts showing hedge positions unless there are additional motives for not doing so. We emphasize the simplicity of this example and the need to reinvestigate this issue in more complex settings.

## 5. First Period Investment

Thus far in this article we have assumed that the firm's first-period investment choice was given. We have then demonstrated that the manager's hedging decision may have real consequences regarding the firm's second-period investment choice. In this section we demonstrate that if the manager is also responsible for a first-period investment decision, this decision may also be distorted by the equilibrium hedging policy.

Suppose that the manager must choose between two projects in the first period. One project has a payoff $X + \theta Z$, where $\theta$ has a distribution that is symmetric around 0, and satisfies the MLRP. A second "superior" project has a payoff $X + \delta + k\theta Z$ with $\delta > 0$ and $k > 1$. Of course, risk-neutral shareholders unambiguously prefer the second project. We argue, however, that a manager who cannot effectively hedge may prefer not to take the superior project because of its increased risk exposure. Under the assumption that shareholders do not know the identity of the superior project and hence cannot mandate it contractually, this implies that the firm's hedging policy can lead to suboptimal investment *ex ante.*

We demonstrate this result with the following two propositions. In the following, we maintain the symmetry and monotonicity Assumptions A and C.

**Proposition 10.** *If the manager cannot hedge, or if the ineffective hedging equilibrium of Proposition 3 applies, then for all $\delta$ sufficiently small, there exists an equilibrium in which the manager chooses the inferior project. Moreover, an equilibrium in which the manager chooses the superior investment does not exist.*

*Proof.* Define $G_k(X + k\theta Z, Z) = E[a \mid X + k\theta Z, Z]$. Because $\theta$ is symmetric and satisfies MLRP, $G_k(Y, Z) = G_k(Y, -Z)$ and $G_k(\cdot, Z)$ is odd and increasing. From the lemma, $E[u(G_k(X + k\theta Z, Z)) \mid |Z|] < E[u(G_k(X + \theta Z, Z)) \mid |Z|]$. Thus,

$$E[u(G_k(X + k\theta Z, Z))] < E[u(G_k(X + \theta Z, Z))].$$

Therefore, for $\delta$ sufficiently small, $E[u(G_k(X + k\theta Z, Z))] < E[u(G_k(X - \delta + \theta Z, Z))]$. This implies that if the market sets a wage based on investment in the superior project, the manager prefers instead to invest in the inferior project, so such an equilibrium cannot exist.

A similar argument implies that $E[u(G_1(X + \delta + k\theta Z, Z))] < E[u(G_1(X + \theta Z, Z))]$. This confirms the possibility of an equilibrium with investment in the inferior project. ∎

**Proposition 11.** *Suppose the manager is allowed to hedge, and the maximal hedging equilibrium of Proposition 6 applies. Then the manager always chooses the superior investment.*

*Proof.* If the manager invests in the superior project and hedges fully, the equilibrium wage is given by $G = E[a \mid X + \delta]$. Given this wage schedule, our prior results imply that the manager's hedging decision is optimal. Finally, because the wage schedule is monotonic, for any hedging decision the manager prefers the superior investment. The same logic can be used to rule out an equilibrium with the inferior investment. ∎

## 6. Conclusion

In this article we investigate the role of managerial career concerns in determining corporate financial hedging policy. We find that alternative accounting standards can substantially affect equilibrium hedging. In the context of our model, standard hedge accounting results in full hedging by managers. Alternatively, if separate accounts of hedging activity are provided by managers, then full hedging is not a robust equilibrium, whereas no hedging by managers is always an equilibrium.

Moreover, we demonstrate that even though shareholders are risk neutral, the information effect of hedging implies that hedging policy can have a real effect on the value of the firm. In particular, we show that the increased information due to hedging may outweigh the information provided by disclosure of hedging activity. Therefore, standard hedge accounting can improve the firm's future investment decisions. In addition, standard hedge accounting may also increase the manager's incentive to make an optimal initial investment decision.

Of course, the sharp conclusions we obtain are at the expense of relatively strong assumptions on the underlying model. If hedging involved expected gains or losses (i.e., $E[Z] \neq 0$), for example, managers would deviate to some extent from full hedging in the case of aggregate hedge accounting. Another key assumption necessary for deriving the specific results in our paper is the restriction to short-term fixed-wage contracts. If this were generalized to allow for linear contracts, for instance, our results would be somewhat altered. If hedge accounts are not disclosed, full hedging is still the natural equilibrium. Under full disclosure, however, an equilibrium would generally exist in which the manager "over hedges" (i.e., takes a hedge position whose magnitude exceeds that of full-hedging).[30]

We do feel, however, that the main intuition of our results is robust. In particular, under full disclosure, hedge positions have real effects primarily to the extent that they act as a signal and reveal private information known to the manager. Alternatively, if hedge positions are not disclosed (as with standard hedge accounting), hedging has a more direct impact on the riskiness of the firm's profits and managers' wages. Thus, these accounting issues are likely to have important consequences for hedging policy, though the specific equilibrium outcomes will be sensitive to the precise environment being modeled.

One potentially interesting extension of our results would be to a dynamic setting in which learning about managerial ability is ongoing. In this case, one would expect that the importance of the reputational effects that we consider would change over time. In particular, early in a manager's career, the reputational impact of reported profits is likely to be large, both because the prior on the manager's ability is diffuse (so that next period's wage is very sensitive to current performance), and because current profits will affect all future wage decisions.[31] Thus, we might expect that the reputational and informational consequences of hedging would be most severe for younger managers, and it is therefore these managers who might be most sensitive to the choice of an accounting standard.

The results of this article raise many questions regarding the choice of accounting standards by shareholders and managers. Ideally, we would like to extend the model to incorporate this decision. In addition, we would like to include the possibility of long-term managerial incentive schemes. Such contracts might mitigate the importance of reputational considerations for managers, though they would still

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[30] The intuition for this follows naturally from Proposition 5. Full hedging could not be an equilibrium because slightly overhedging would lead to only a second-order increase in the risk of profits, but a first-order decrease in the sensitivity of the wage to profits.

[31] We are grateful to the editor for this observation.

retain some importance due to the manager's option to quit and the possibility of *ex post* renegotiation.

Another area for future research is the effect of managers having private information regarding their own ability or the mean level of firm profits. Intuitively, we would expect that in this case, more able managers (or those with good news) would prefer to hedge so as to preserve the likelihood of a good outcome. Alternatively, managers with bad news or low ability might prefer to increase risk and hope for a lucky draw.[32] Finally, we would like to improve the model by more fully endogenizing the choice of production plans and then explore the interaction of production and financial policy.

## Appendix: Proof of Lemma

**Lemma.** *Suppose Y is symmetric and unimodal, Z is independent and symmetric with mean 0, and G is strictly monotone. If* $|k| > |j|$, *and if* $E[G(Y + jZ)] \geq E[G(Y + kZ)]$, *then* $G(Y + jZ)$ *second-order stochastically dominates* $G(Y + kZ)$.

*Proof.* Let $H_k$ denote the cumulative distribution function of $G(Y + kZ)$. To establish the theorem it is enough to show, for $k > j \geq 0$, that $H_j$ satisfies the usual condition for second-order stochastic dominance of $H_k$; that is, for any $t$,

$$b(t) \equiv \int_{-\infty}^{t} \left[ H_j(w) - H_k(w) \right] dw \leq 0.$$

For this, let $B$ denote the cumulative distribution function of $Y$ and let $C$ denote the cumulative distribution function of $Z$. Since $G$ is strictly monotonic, $G^{-1}$ exists, so we have

$$H_k(w) = \int_{-\infty}^{\infty} \int_{-\infty}^{G^{-1}(w)-kz} dB(u)\, dC(z).$$

Then

$$b(t) = \int_{-\infty}^{t} \int_{-\infty}^{\infty} \int_{G^{-1}(w)-kz}^{G^{-1}(w)-jz} dB(u)\, dC(z)\, dw.$$

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With the change of variables $s = G^{-1}(w)$,

$$h(t) = \int_{-\infty}^{t} \int_{-\infty}^{\infty} \int_{s-kz}^{s-jz} dB(u) \, dC(z) \, dG(s)$$

$$= \int_{-\infty}^{t} E[B(s - jZ) - B(s - kZ)] \, dG(s).$$

We now make use of the fact that the density of $Y$ is symmetric and monotone on each side of its mean. From this, for any constant $z$,

$$B(s - jz) - B(s - kz) \geq B(s + kz) - B(s + jz) \text{ if and only if } s \geq 0.$$

Now, since $Z$ and $-Z$ are identically distributed,

$$E[B(s + kZ) - B(s + jZ)] = -E[B(s - jZ) - B(s - kZ)].$$

It follows that $E[B(s - jZ) - B(s - kZ)] \geq 0$ if and only if $s \geq 0$. This plus the fact that $G$ is increasing implies that $h(t) \leq h(+\infty)$. Thus, to complete the proof, we must show $h(+\infty) \leq 0$. But $h(+\infty) = E[G(Y + kZ) - G(Y + jZ)] \leq 0$ by hypothesis. ∎

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