Implications of firm heterogeneity for the accounting of cash flow hedges under SFAS 133

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Abstract

A decade of controversy surrounding the fair-value accounting of derivatives suggests that firms may change or, ultimately, abandon their hedging programs because fair-value accounting can potentially increase earnings volatility and misrepresent the underlying economic performance. The alternative to fair-value accounting offered by the FASB to firms with hedging programs, hedge accounting, is allowed only if the designated hedge passes a prospective test for hedge effectiveness. We derive a closed-form solution for prospective hedge effectiveness in an established model of how firms should hedge and find systematic cross-sectional variation in firms' ability to meet the "highly effective" criterion under SFAS 133. Because hedging programs that fail to jump the highly effective bar can be valuable from an economic perspective, the bar on hedge effectiveness can be value destroying if firms that fail to qualify for hedge accounting give up cash-flow hedging. The cross-sectional variation in prospective hedge effectiveness implies that these potential accounting distortions are not uniform across firm types. We also show that prospective hedge effectiveness is not a reliable signal of a large speculative component in a derivative portfolio, which is the prime motivation for the current hedge accounting regulations. These findings suggest that prospective hedge effectiveness testing with an across-the-board threshold may not serve its purpose well.

Keywords: Cash-flow hedging, earnings hedging, nonhedgeable risk, hedgeable risk, SFAS 133, fair-value accounting, hedge accounting, nonfinancial value-maximizing firms, hedge effectiveness, incomplete markets.

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1. Introduction

The fair-value accounting of derivatives under SFAS 133 can potentially boost earnings volatility due to mismatch in the timing of the recognition of gains and losses on derivative instruments entered into for hedging purposes and those of the hedged items (Finnerty & Grant, 2002; Lins, Servaes, & Tamayo, 2009; Zhang, 2009). Because most CFOs prefer stable earnings and are willing to sacrifice value to achieve a smooth earnings path, increased earnings volatility is considered problematic by many companies (Graham, Harvey, & Rajgopal, 2005). The potential solution offered by the FASB intended to mitigate excessive earnings volatility, hedge accounting, is applicable only for hedging strategies deemed "highly effective" according to a standard accepted by the FASB. Focusing exclusively on cash-flow hedges under SFAS 133, that is, the type of hedge that offsets the variability of the cash flow of a balance sheet item or a forecast transaction, this paper sheds new light on why so many firms appear to be struggling with surmounting the "highly effective" hurdle (Comiskey & Mulford, 2008).[1] On the basis of an established model of hedging in which financial hedges interact with the unhedgeable business risk of a firm as well as the firm's production costs, we derive a closed-form solution for prospective hedge effectiveness conditional on firm type and linear hedging strategies. Next, we check if a set of optimal hedges could pass the SFAS 133 hedge effectiveness test and find that economically optimal hedges in many instances are classified as ineffective. This could reduce firm value if firms do not want to introduce the higher earnings volatility associated with marking to market the hedge and not the underlying exposure being hedged.

A key finding is that firms with high operating leverage are least likely to qualify for hedge accounting, that is, the highly effective hurdle is bound to exclude certain types of

[1] Derivatives that meet the requirements of SFAS 133 may be designated as accounting hedges. The designations of derivatives for accounting purposes are either as fair-value hedges or cash-flow hedges. Whereas a cash-flow hedge results when derivatives are employed to hedge the exposure to expected future cash flows that is attributable to a particular risk, a fair-value hedge protects the fair value of recognized assets and liabilities or firm commitments (Comiskey & Mulford, 2008).

firms. Because the maximum attainable hedge effectivess varies significantly across firm types, a high threshold that is no match for firms with low operating leverage could still represent an insurmountable hurdle for firms with high operating leverage. It follows that low hedge effectiveness is not necessarily a reliable signal of a large speculative component in a firm's derivative holdings. Sapra (2002) defines a benchmark for prudent risk management as the sum of a pure hedge component, consistent with risk minimization, and a speculative component *"that is consistent with the firm's beliefs and that is in the best interest of the shareholders"* (p.939). The FASB's hedge effectiveness hurdle may be understood in terms of this "pure hedge"- speculation paradigm. When the tested hedge effectiveness is low, the FASB would conclude that there is a large speculative component in the given derivative portfolio and therefore prescribe fair-value accounting. Consequently, as long as prospective hedge effectiveness is compared to a fixed across-the-board ruling on minimum hedge effectiveness, and not to the maximum attainable hedge effectiveness under the associated pure hedge, many firms with high operating leverage will fail to qualify for hedge accounting. These firms could face difficult tradeoffs between accounting and economic objectives.[2]

A premise for the analysis presented in this paper is that a cash flow hedge differs fundamentally from a fair-value hedge. For a fair-value hedge, it makes sense to book the net change in the value of a given stock of some asset or liability and some stock of derivatives over a given accounting period in the income statement of the firm. The rationale for regarding the net change in value as hedge ineffectiveness is that the hedging program was designed to protect the value of the given stock of asset or liability in the first place. The same correspondence between the underlying hedged object and the derivative is missing in a cash-

[2] Nocco and Stulz (2006) refer to this tradeoff as the accounting problem: "For example, under the current accounting treatment of derivatives, if a company uses derivatives to hedge an economic exposure but fails to qualify for hedge accounting, the derivatives hedge can reduce the volatility of firm value while at the same time increasing the volatility of accounting earnings" (p.16). Charnes, Koch and Berkman (2003) refer to Franklin Savings and Loan as an extreme example of the potential consequences of earnings volatility resulting from the failure to qualify for hedge accounting. The resulting earnings volatility could trigger debt covenants that might further reduce the firm's equity below minimum capital requirements, which ultimately led regulators to close Franklin Savings and Loan, ultimately resulting in its demise.

flow hedge; it is the future cash flow that is hedged, not some estimated interim value of the combined two. Therefore, the degree of hedge ineffectiveness is not revealed before both cash flows are realized, that is, when the period in question is history. For cash flow hedges that extend beyond the current accounting period, which is the prime focus of this paper, any interim change in net value of the combined position is therefore considered irrelevant.

Although there are many studies discussing different techniques for measuring hedge effectiveness (Finnerty & Grant, 2002; Hailer & Rump, 2005; Kalotay & Abreo, 2001; Kawaller & Koch, 2000), to the best of our knowledge, no other studies systematically analyze what types of firms are eligible for hedge accounting. If earnings volatility matters as suggested by the study of Graham et al. (2005), our model of hedge effectiveness provides a theoretical explanation for the finding of Lins et al. (2009) that many firms have changed their risk management policies as a direct consequence of the new accounting standards. Their findings suggests that potential accounting mismatch can create excessive earnings volatility that might push reporting issues to the forefront of firms' agenda and, ultimately, induce changes in firms' hedging strategies.[3] Consequently, firms that fail to meet the FASB's requirements for hedge accounting could choose to *"give up economic value in exchange for smooth earnings"* relative to a base case in which any type of non-accounting related deadweight costs that can justify firm hedging is addressed (Graham et al., 2005, p.5).[4] We analyze the value-destroying potential of the FASB's highly effective criterion should firms choose to abandon their hedging programs on account of unacceptable earnings volatility, and show that hedging programs intended to maximize firm value under a risk-neutral measure can be valuable for hedge effectiveness lower than the minimum 80% threshold under the regression method (Boze, 1990; Finnerty & Grant, 2002). Under the current accounting

3 The more restrictive assumption that earnings volatility always matters, not only when it turns extreme due to accounting mismatch, would just serve to strengthen the possibility of a real impact on firm hedging.

[4] A recent update on possible motivations for hedging of nonfinancial firms discussed in the finance literature is provided by Aretz and Bartram (2010).

regime, many valueable hedging programs will be incorrectly categorized as speculative and the frequency of miscategorization will not be uniform across firm types.

2. Risk Management under SFAS 133

Prior to SFAS 133, the accounting treatment of derivatives depended on the claimed purpose of the derivative instrument. If a firm held derivatives for speculation, the firm had to recognize these at fair value on the balance sheet and recognize any unrealized gains or losses in the income statement. On the other hand, if a firm held derivatives for hedging purposes, the accounting treatment would be determined by the accounting treatment of the hedged item (Zhang, 2009, p. 246). For example, gains and losses on derivatives supposed to hedge forecasted cash flows were recorded when these cash flows were recognized (deferral-hedge accounting). This practice ended with the introduction of SFAS 133, whose main principle requires that derivatives be recognized as either speculative assets or liabilities at fair value on the balance sheet and that unrealized gains and losses be reported in the income statement. Consequently, the FASB seems to have adopted the position that *"derivatives create new risks that are poorly understood, and therefore that providing information on the market value changes of firms derivatives positions will make firms' risk characteristics more transparent to investors in the capital market"* (Kanodia, Mukherji, Sapra, & Venugopalan, 2000, p.54). A contrasting view is that the reported earnings volatility under fair-value accounting is misleading and that, rather than creating new risks, derivatives instruments are used to manage and reduce firms' inherent risk exposures. In any case, it remains a fact that fair-value accounting can create a mismatch between the timing of the recognition of gains and losses on derivative instruments entered into for hedging purposes and those of the hedged item. Because earnings include the changed value of derivatives that mature in future financial years under SFAS 133, the difference between earnings under deferral-hedge accounting and SFAS 133 may be substantial. As a result, fair-value accounting may induce substantial variation into earnings and book equity, which can be problematic for firms with hedging programs that extend beyond the current accounting period (Finnerty and Grant, 2002; Lins, Servaes, and Tamayo, 2009).

Although the main principle of SFAS 133 is that all changes in fair values be reported in the income statements, companies can recognize gains and losses on a hedge portfolio in the income statement in the same period as offsetting gains and losses on the hedged item under the hedge accounting rules of SFAS 133. If the requirements for hedge accounting are met, all value changes in the derivatives are recognized as a "hedging reserve" in equity. The fair-value changes are not recorded in the income statement until the hedged transaction affects profits or losses. Although the regulations of SFAS 133 on hedge accounting in all instances induce volatility into book equity, these rules at least partly shield earnings from increased volatility caused by changes in the fair value of the hedging instruments when some of these are settled in future financial periods. However, SFAS 133 requires the hedging program to be "highly effective", meaning that the hedge effectiveness must fall within a range of 80%-125% over the life of the hedge as measured by "the dollar offset method" or greater than or equal to 80% as measured by the regression method.[5] The "highly effective" requirement must be met both *ex ante* and *ex post*; companies that have adapted to hedge accounting rules face the risk of hedge accounting restatements due to failed retrospective tests for hedge effectiveness or inadequate documentation (Comiskey and Mulford, 2008; Corman, 2006). Even if the hedge's effectiveness is sufficient to qualify for hedge accounting, the ineffective part of the hedge must still be recorded in the income statement. Overall, hedge accounting is optional, and the management must weigh the costs and benefits when considering whether to use it. There is thus a risk that firms choose to alter their hedging

[5] SFAS 133 do not endorse a specific testing methodology to be applied to qualify for hedge accounting; see the discussion in Finnerty and Grant (2002).

strategies rather than adapting to the hedge-accounting regulations of SFAS 133. In that case, the accounting standards have real consequences for firms' financial strategies.

The possible influence of SFAS 133 on earnings volatility has generated intense debate on whether the current accounting regime has real consequences for firms' risk-management policies. Empirical studies by Sing (2004) and Park (2004) find no increases in earnings volatility following the introduction of SFAS 133 and thus conclude that the impact of SFAS 133 may not be as significant as has been claimed. A similar conclusion is reached by Li and Stammerjohan (2005). However, as Zhang (2009) notes, if the increase in earnings volatility is material and costly and a firm adjusts its derivatives portfolio in anticipation of this potential cost, we may not observe any increase in earnings volatility after the adoption of the new accounting standards. Accounting for this possibility, Zhang nevertheless concludes that firms motivated by a hedging instead of a speculative motive did not change their risk-management practices after the adoption of SFAS 133 in the U.S. When asked directly, a different story unfolds: in a survey by Lins et al. (2009), more than 40% of the companies state that they have altered their risk-management strategies as a direct consequence of the new accounting standards. This is evidence that the new accounting standards have affected risk-management behavior for large groups of companies. There is also evidence to suggest that the effects of the new accounting standards are a function of country-, industry- and firm-specific characteristics (Lins, Servaes, and Tamayo, 2009). We now present analytical evidence that sheds new light on these findings.

3. Prospective hedge effectiveness in the economic setting of Brown and Toft

Consider firms with hedging programs designed to maximize value in anticipation of deadweight costs concurrent with low future (economic) profits. Brown and Toft (2002) derive optimal hedging strategies for firms that operate in this economic setting and motivate their deadweight cost function as being *”consistent with a firm that experiences high costs when profits are low and low costs when profits are large”* (p. 1290). Furthermore, these authors argue that *”indirect bankruptcy costs at t = 1 (affecting revenues at time t > 1) could impact the hedging decision in a way that is well approximated by an exponentially declining cost function. Another example could be a firm confronting costly access to external capital markets (Froot & Stein, 1993) where external financing costs increase exponentially in the amount of funds raised”* (p. 1291).[6] We derive a closed-form solution for prospective hedge effectiveness for these firms conditional on linear hedging strategies. In this incomplete market setting, in which firms maximize value under a risk-neutral measure, there is no such thing as 100% hedge effectiveness. Next, we characterize the risk exposures of firms bound to fail a prospective test of hedge effectiveness under SFAS 133 using this measure of hedge effectiveness.

3.1 HEM – a measure of prospective hedge effectiveness

In the economic environment of Brown and Toft (2002), the future net profits of a firm that faces a hedgeable price risk ($\tilde{p}$), an unhedgeable quantity risk ($\tilde{q}$), constant marginal costs (s_1) and fixed costs (s_2) are given as $(\tilde{p}-s_1)\tilde{q}-s_2$. For a firm that adheres to linear hedging strategies, these random net profits are modified by derivatives payoffs given by the number of forward contracts (a) times the difference between the random price and the forward price f:[7]

$$\widetilde{np}(a)=(\tilde{p}-s_1)\tilde{q}-s_2+a(\tilde{p}-f) \tag{1}$$

[6] See Aretz and Bartram (2010), Bartram et al. (2009), Smith (2008), and Brown and Toft (2002) for different types of deadweight costs that could motivate this type of hedging program. Brown and Toft’s (2002) model of how firms should hedge applies to all sorts of markets where the objective measure (the P-measure) may differ from the pricing measure (the Q-measure), so the possibility of risk premia is not ruled out. The only assumption is that firms do not pick their own probability measure during optimization, that is, they use the risk-neutral measure satisfying the no-arbitrage assumption.

[7] In the following, dependence on all other variables and parameters except for the hedge ratio, *a*, is suppressed for notational convenience.

Brown and Toft (2002) show that the optimal number of forward contracts for firms maximizing value under a (risk neutral) bivariate normal probability measure is a^* given a deadweight cost function $c_1 e^{-c_2 \widetilde{np}(a)}$, where "the parameter c_1 measures the overall level of deadweight costs, c_2 controls slope and curvature" (p. 1291), and the expected production and price are set equal to one:

$$a^* = -1 - (1 - s_1)\,\rho \frac{\sigma_{\tilde{q}}}{\sigma_{\tilde{p}}} + (1 - s_1)\left(1 - \rho^2\right) c_2\, \sigma_{\tilde{q}}^2 \tag{2}$$

It is proved in the appendix that the variance of firms' net profits under these conditions are given as

$$\begin{aligned}\mathrm{var}\left(\widetilde{np}\left(a^*\right)\right) = {} & \sigma_{\tilde{q}}^2\left(1 - 2s_1 + s_1^2\right) + \sigma_{\tilde{p}}^2\left(1 + 2a^* + \left(a^*\right)^2\right) \\ & + \sigma_{\tilde{q}}^2\sigma_{\tilde{p}}^2\left(1 + \rho^2\right) + 2\rho\sigma_{\tilde{q}}\sigma_{\tilde{p}}\left(1 - s_1\right)\left(1 + a^*\right)\end{aligned}, \tag{3}$$

in which case prospective hedge effectiveness may be defined as follows, in the spirit of Ederington (1979, p.164):

$$HEM = 1 - \frac{\mathrm{var}\left(\widetilde{np}\left(a^*\right)\right)}{\mathrm{var}\left(\widetilde{np}\left(a\right)\right)\Big|_{a=0}} = \frac{-\sigma_{\tilde{p}}^2\left(2a^* + \left(a^*\right)^2\right) - 2\rho\sigma_{\tilde{q}}\sigma_{\tilde{p}}\left(1 - s_1\right)a^*}{\sigma_{\tilde{q}}^2\left(1 - 2s_1 + s_1^2\right) + \sigma_{\tilde{p}}^2 + \sigma_{\tilde{q}}^2\sigma_{\tilde{p}}^2\left(1 + \rho^2\right) + 2\rho\sigma_{\tilde{q}}\sigma_{\tilde{p}}\left(1 - s_1\right)} \tag{4}$$

Because *"tests used to document hedge effectiveness must be consistent with the hedger's stated approach to risk management"* (Finnerty & Grant, 2002, p. 97), *HEM* differs from Ederington's measure in one respect. It is calculated for the value-maximizing instead of the variance-minimizing number of forward contracts, which in Brown and Toft's model may be shown to be the limiting case of a^* as c_2 approaches zero, that is, $\lim_{c_2 \to 0} a^* = a^{MinVar}$. Thus, while *HEM* represents "attained effectiveness" in the two-part framework for measuring hedge effectiveness of Charnes, Koch, and Berkman (2003), "potential effectiveness" may easily be represented simply by setting c_2 close to zero. Besides being closely related to

Finnerty and Grant's (2002) "Regression method measure of variability reduction" (*RVR*) in the limiting case of a minimum variance hedging strategy, *HEM* is also fully consistent with Kalotay and Abreo's (2001) volatility reduction measure (*VRM*) as long as the threshold for hedge effectiveness properly reflects the choice of measure.[8] Therefore, *HEM* is fully compliant with the spirit of the FASB's recommendations while correcting for the major shortfalls of other tests recommended by the FASB (Kalotay & Abreo, 2001, p. 93).

In conclusion, *HEM* supports two behavioral assumptions. Either we can assume that the object of interest is value-maximizing firms, or we can mimic the objective function of firms minimizing the volatility of future profits by setting c_2 close to zero. *HEM* will generally be lower for value-maximizing firms than for firms minimizing the volatility of future profits; however, it turns out that the general findings apply to both types of firms.

3.2 Heterogeneity in firms' ability to pass the "highly effective" hurdle

In their study of how firms should hedge, Brown and Toft (2002) analyze a base case and several alternative risk exposures or firm types. Figure 1 illustrates the decomposed profit variance and prospective hedge effectiveness (*HEM*) for some of these cases across different levels of marginal cost or, alternatively, operating leverage[9]. Firms with high operating leverage appear less likely to pass a prospective hedge effectiveness test than those with low low operating leverage. Furthermore, firms facing negative price-quantity correlations appear less likely to jump the "highly effective" hurdle than firms facing positive correlations: four out of five fail for ρ = -0.5, three out of five fail for ρ = 0, and two out of five fail for ρ = 0.5 in the base case exposures of Figure 1.

[8] Following Finnerty and Grant's (2002) choice of an 80% threshold for RVR, an 80% threshold for HEM translates to a 55.3% threshold for Kalotay and Abreo's (2001) VRM measure defined as 1 – [stdev(hedge package)/stdev(item being hedged)] (p. 96).

[9] Operating leverage is sometimes defined as the relative proportion of fixed versus variable cost (Berk & DeMarzo, 2010), sometimes as the ratio of the contribution margin (revenues minus variable costs) to operating income (revenues minus variable and fixed costs) (Penman, 2010). Both definitions convey the same idea for our purposes.

[Insert Figure 1 here]

Figure 1. Decomposed profit variance for Brown and Toft's (2002) base case and one instance of high price risk. HEM measures the prospective hedge effectiveness as defined in equation (4), the profit variance is calculated as in equation (3), the hedged risk equals $HEM \times \operatorname{var}\left(\widetilde{np}\left(a^{*}\right)\right)$, and the unhedged risk equals $\left(1-HEM\right) \times \operatorname{var}\left(\widetilde{np}\left(a^{*}\right)\right)$. Brown and Toft's base case corresponds to the parameterization s_1=0.25, s_2=0.4, $\sigma_p=\sigma_q$ =0.2, $\mu_p=\mu_q$=1,c_1=0.1,c_2=5, whereas the high price risk (lower right) corresponds to the base case with σ_p=0.3.

A paradoxical implication of the FASB's "highly effective" hurdle is that the firms facing the highest pre-hedge profit variability, that is, revenue hedgers and firms with high operating leverage, are in many instances the firms being excluded from hedge accounting. This is the case in Figure 1 when the unhedgeable risk is uncorrelated or positively correlated with the hedgeable risk. With zero correlation, the absolute amount of hedged risk is essentially the same across different firm types. The absolute amount of hedged risk is even higher for firms excluded from hedge accounting than for firms that qualify for hedge accounting when $\rho = 0.5$. Indeed, it is difficult to argue the case for denying a revenue hedger hedge accounting while allowing a firm with low operating leverage hedge accounting when both face a positive price-quantity correlation (lower left in Figure 1). In absolute terms, the former type of firm faces a higher prehedge profit variability and is able to eliminate more risk than the latter firm. Still, only the firm with low operating leverage will qualify for hedge accounting. Figure 2 illustrates that these findings also apply to firms that minimize profit volatility; hedge effectiveness is only marginally higher for pure hedge firms.

[Insert Figure 2 here]

Figure 2. Decomposed profit variance for Brown and Toft's (2002) base case and one instance of high price risk for the limiting case c_2=0 (pure hedge) . HEM measures the prospective hedge effectiveness as defined in equation (4), the profit variance is calculated as in equation (3), the hedged risk equals $HEM \times \operatorname{var}\left(\widetilde{np}\left(a^{*}\right)\right)$, and the unhedged risk equals $\left(1-HEM\right) \times \operatorname{var}\left(\widetilde{np}\left(a^{*}\right)\right)$. Brown and Toft's base case corresponds to the parameterization s_1=0.25, s_2=0.4, $\sigma_p=\sigma_q$ =0.2, $\mu_p=\mu_q$=1,c_1=0.1,c_2=5, whereas the high price risk (lower right) corresponds to the base case with σ_p=0.3.

The cross-sectional variation in firms' ability to qualify for hedge accounting in Figure 1 and 2 motivates the further examination of a more diverse set of risk exposures in Figure 3. The patterns identified in Figure 1 and 2 emerge in all cases illustrated in Figure 3. Because a negative price-quantity correlation makes the relation between net profits and price less clear cut, it is not surprising that firms that face positive correlations are more likely to qualify for hedge accounting than firms that face negative correlations. The finding that firms with high operating leverage usually cannot qualify for hedge accounting is less intuitive. Part of the explanation is that variable costs serve as a natural hedge for a firm's net profits: an increase (decrease) in a firm's revenues due to higher (lower) production will partly be countervailed by higher (lower) variable production costs. A higher marginal cost indicates that the interaction term $(\tilde{p} - s_1) \times \tilde{q}$ will, on average, be lower for a given price and quantity volatility. The increased marginal cost amounts to a shift in location for the term $(\tilde{p} - s_1)$, which does not influence the absolute amount of inherent price and quantity risk in the model. However, because this term decreases on average as the variable cost s_1 increases, the significance of the interaction between the price and quantity risk in the term $(\tilde{p} - s_1) \times \tilde{q}$ decreases as s_1 increases. Consequently, there is some similarity between a decrease in the quantity risk for a given price risk and an increase in marginal costs: in both cases, the influence of the unhedgeable risk tends to decrease and, consequently, hedge effectiveness increases. Although there are exceptions[10], this general rule applies to most economically interesting cases.

[Insert Figure 3 here]

Figure 3. Prospective hedge effectiveness for value-maximizing firms facing the random net profits $\widetilde{np} = (\tilde{p} - s_1)\tilde{q} - s_2 + a^*(\tilde{p} - f)$, where s_1 and s_2 denote marginal and fixed costs, respectively, a^* is the value-maximizing number of forward contracts in Brown and Toft's (2002) model, and f is the forward price. All firms that face risk exposure with prospective hedging efficiency below the 80% threshold (dashed line), given

[10] For example, $\partial HEM / \partial s_1 < 0$ when s_1 is smaller than (approximately) 0.5 for the parameters $\rho = -0.5, \sigma_{\tilde{p}} = 0.05, \sigma_{\tilde{q}} = 0.2,$ and $c_2 = 5$, but this is a special case with very low hedgeable risk relative to unhedgeable risk.

by $HEM = 1 - \mathrm{var}\left(\widetilde{np}\left(a^*\right)\right) / \mathrm{var}(\widetilde{np}\left(0\right))$, fail to qualify for hedge accounting (Ederington, 1979; Finnerty & Grant, 2002). The four cases correspond to Brown and Toft's parameterizations as follows: *Base case*: s_1=0.25, s_2=0.4, σ_p=σ_q=0.2, σ_q=0.2, μ_P=μ_Q=1,c_1=0.1,c_2=5. *Earnings volatility minimization*: base case with c_2=0. *High price volatility*: base case with σ_p=0.3. *Low price volatility*: base case with σ_p=0.1.

There are important policy as well as empirical implications of these findings. An obvious empirical implication is that two groups of otherwise identical nonfinancial firms, one with high operating leverage and another with low operating leverage, are expected to differ in terms of accounting practices. While few firms in the first group are expected to use hedge accounting, a significantly higher fraction of the firms in the other group are expected to use hedge accounting, ceteris paribus. Another implication is that firms that abandon their hedging programs on account of unacceptable earnings volatility is expected to be revenue hedgers and firms with high operating leverage, given the findings of Graham et al. (2005).

3.3 Hedge effectiveness and the value of a hedging program

Few would dispute that a high hedge effectiveness is preferable, however, does it follow that hedging strategies that fail to reduce the risk exposure by 80% or more are inferior in economic terms? We address this question by calculating the relative increase in firm value due to a hedging program in Brown and Toft's (2002) model of how firms should hedge for a diverse set of firm types. Next, we divide these numbers into two groups: firms that qualify for hedge accounting and firms that do not.

Panel A: Base case (s_1=0.25, s_2=0.4, σ_P=0.2, μ_P=μ_Q=1,c_1=0.1,c_2=5)

σ_Q \ ρ	**0.00**	**0.05**	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**
-0.50	0.035	0.030	0.026	0.021	0.015	0.009	0.003
-0.25	0.035	0.033	0.030	0.027	0.024	0.019	0.014
0.00	0.035	0.035	0.035	0.035	0.034	0.033	0.031
0.25	0.035	0.038	0.040	0.043	0.046	0.049	0.053
0.50	0.035	0.040	0.045	0.052	0.059	0.067	0.077

Panel B: Revenue hedging (s_1=0, s_2 = 0.65)

σ_Q \ ρ	**0.00**	**0.05**	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**
-0.50	0.035	0.028	0.021	0.015	0.008	0.002	0.001
-0.25	0.035	0.031	0.028	0.024	0.020	0.014	0.006
0.00	0.035	0.035	0.036	0.037	0.037	0.038	0.036
0.25	0.035	0.039	0.045	0.051	0.060	0.072	0.088
0.50	0.035	0.044	0.054	0.068	0.086	0.113	0.152

Panel C: Low operating leverage (s_1=0.65, s_2 = 0)

σ_Q \ ρ	**0.00**	**0.05**	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**
-0.50	0.035	0.035	0.034	0.034	0.033	0.032	0.030
-0.25	0.035	0.035	0.034	0.034	0.033	0.032	0.030
0.00	0.035	0.035	0.035	0.034	0.033	0.033	0.031
0.25	0.035	0.035	0.035	0.035	0.034	0.034	0.033
0.50	0.035	0.035	0.035	0.035	0.035	0.035	0.035

Panel D: Base case with high deadweight costs (c_2=8)

σ_Q \ ρ	**0.00**	**0.05**	**0.10**	**0.15**	**0.20**	**0.25**	**0.30**
-0.50	0.048	0.042	0.036	0.030	0.023	0.012	0.000
-0.25	0.048	0.045	0.042	0.040	0.036	0.028	0.014
0.00	0.048	0.048	0.050	0.051	0.053	0.053	0.049
0.25	0.048	0.052	0.057	0.064	0.073	0.085	0.100
0.50	0.048	0.056	0.065	0.078	0.095	0.120	0.155

Table 1. The relative increase in firm value for firms that adhere to linear hedging strategies in the Brown and Toft (2002) setting. The cases when hedge accounting is inapplicable, that is, when firms are unable to surmount the 80% hedge effectiveness threshold is marked with a grey background. Panel B-D differ from the base case assumptions of Panel A only by the assumptions listed in the parentheses. Note that the column σ_Q = 0.2 corresponds to Brown and Toft's base case.

Panel A of Table 1 lists the relative increase in firm value in the neighborhood of the base case assumptions of Brown and Toft (the column $\sigma_{\tilde{q}} = 0.2$) under a linear hedging program. The hedging program is economically significant for all base case firms, the lowest increase in firm value being 1.5%, yet hedge accounting is inapplicable for these firms. Even if the volatility of the unhedgeable risk is reduced to 15%, all firms except the one facing ρ = 0.5

are excluded from hedge accounting in spite of highly valuable hedging programs. The marginal cost is reduced to zero in Panel B of Table 1, and to keep the expected profit as in Panel A, fixed costs are increased to 0.65. Except for the negative correlation -0.5, perhaps, all the base case firm types ($\sigma_{\tilde{q}} = 0.2$) run economically valuable hedging programs but fail to pass the prospective hedge effectiveness test. Even when the quantity volatility is reduced to 10%, this holds for the ρ = -0.5, the ρ = -0.25, and the ρ = 0 firm types. These firms increase their value by more than 2% by running a hedging program. Panel C illustrates the reverse situation when the marginal cost is increased and the fixed cost is decreased to keep expected profits as in Panel A. All base-case firms ($\sigma_{\tilde{q}} = 0.2$) facing low expected contribution margins are now eligible for hedge accounting. This marginal influence of a higher marginal cost s_1 is consistent with the finding in Section 3 that it is generally easier for firms with low contribution margins to pass a prospective hedge effectiveness test. Finally, Panel D lists the relative increase in firm value for variations around the base-case assumptions of Brown and Toft's "high deadweight costs" assumption. The linear hedging program is economically highly valuable for all base case assumptions ($\sigma_{\tilde{q}} = 0.2$). This is also the case when the volume volatility is reduced to 15%, except for in the ρ = 0.5 case. Nevertheless these firms are not eligible for hedge accounting.

We conclude from these findings that, although a higher hedge effectiveness is preferable by almost any standard, hedging programs that fail to pass the "highly effective" hurdle can be economically valuable. Indeed, when deadweight costs turn increasingly large as profits drop, the first 10% reduction in risk is usually economically more important than the last 10% reduction in risk.

3.4 Can hedge effectiveness reliably signal a large speculative component in a derivative portfolio?

One possible interpretation of the prospective test for hedge accounting is that the FASB trusts the hedge effectiveness index to carry sufficient information to meaningfully separate a derivative portfolio primarily motivated by hedging concerns from a derivative portfolio primarily motivated by speculation. We now analyze this position from a slightly different perspective than in the previous section. First, we identify the pure hedge (*PH*) for a diverse set of firm types. This is simply the limiting case of a^* when the deadweight cost function parameter goes to zero. Next, we calculate hedge effectiveness (*HEM*) for each type when the pure hedge specific to each firm type is employed. This procedure yields potential hedge effectiveness for these firm types. Having done that, we increase the number of forward contracts by 0.20 and 0.40, the equivalent of a twenty and a forty percentage point increase in the hedge ratios of these firms, and recalculate hedge effectiveness using this new set of firm-specific strategies. Finally we ask the question; if the increase in the short position in forwards were motivated by speculative motives, would this somehow be revealed by the hedge effectiveness index?

Table 2 demonstrates that the maximum attainable hedge effectiveness varies a lot across firm types, and that the change in hedge effectiveness caused by a deviation from the pure hedge often is small. These findings, which are independent of the deadweight cost function argument in the previous subsection, suggest that hedge effectiveness is a weak signal of the presence of a large speculative position in a given derivative portfolio. A low operating leverage firm would almost certainly qualify for hedge accounting even with a large speculative component in their derivative portfolio, while revenue hedgers and firms with high operating leverage almost certainly will not, with or without the speculative compont.

Panel A: Base case ($\sigma_p=\sigma_q=0.2$, $\mu_P=\mu_q=1, c_2=0$)

	Revenue hedging (s_1=0)			Low operating leverage (s_1=0.8)		
	PH	***PHM20***	***PHM40***	***PH***	***PHM20***	***PHM40***
ρ = -0.5	0.24	0.20	0.09	0.91	0.87	0.73
ρ = 0	0.49	0.47	0.41	0.93	0.89	0.78
ρ = 0.5	0.74	0.72	0.69	0.94	0.91	0.81

Panel B: Low volume volatility (base case with σ_q = 0.1)

	Revenue hedging (s_1=0)			Low operating leverage (s_1=0.8)		
	PH	***PHM20***	***PHM40***	***PH***	***PHM20***	***PHM40***
ρ = -0.5	0.74	0.69	0.53	0.98	0.93	0.80
ρ = 0	0.79	0.76	0.67	0.98	0.94	0.82
ρ = 0.5	0.89	0.86	0.80	0.98	0.95	0.84

Panel C: Low volume and price volatility (base case with $\sigma_p=\sigma_q=0.1$)

	Revenue hedging (s_1=0)			Low operating leverage (s_1=0.8)		
	PH	***PHM20***	***PHM40***	***PH***	***PHM20***	***PHM40***
ρ = -0.5	0.24	0.21	0.09	0.95	0.90	0.76
ρ = 0	0.50	0.48	0.42	0.95	0.91	0.80
ρ = 0.5	0.75	0.73	0.69	0.97	0.93	0.84

Table 2. Hedge effectiveness (*HEM*) for a subset of firm types or risk exposures for three linear hedging strategies: (1) The pure hedge (*PH*), (2) the pure hedge minus 0.20 (*PHM20*), and (3) the pure hedge minus 0.40 (*PHM40*).

Imagine a random sample of hedge effectiveness from an even more diverse set of firm types and that every firm is classified as 'fail' if the observed index is lower than the threshold and 'pass' otherwise. It is evident that this procedure would be anything but successful in separating the wheat from the chaff, given the large variation in the potential (pure) hedge effectiveness, and the moderate sensitivity of hedge effectiveness to deviations from the pure hedge. Apparently, hedge effectiveness cannot reliably signal the presence of a large speculative component in a derivative portfolio.

4. Concluding remarks

We derive a closed-form solution for prospective hedge effectiveness in the economic setting of Brown and Toft (2002) and find that firms with high operating leverage will rarely qualify for hedge accounting, even when the hedging programs are economically valuable. This is because the prospective hedge effectiveness test fails to recognize the economic conditions that motivate a hedging program; it only considers the fraction of some risk exposure being hedged. Depending on how deadweight costs relate to a firm's net profits, however, a hedging program can be economically valuable despite a low hedge effectiveness. We also demonstrate that low hedge effectiveness should not be considered a reliable signal of the presence of a large speculative component of a derivative portfolio. While these results derive from the usual interpretation of Brown and Toft's model as representing *"the product of price and quantity minus the costs of production"* (p.1288), they also apply to the management of a foreign exchange exposure. The unhedgeable risk factor could be given the interpretation of an uncertain future stream of some currency, while the price factor could be some future foreign exchange rate. Accordingly, a hedging program designed to reduce the risk of the home currency value of some uncertain currency stream, a sort of revenue hedging, will rarely qualify for hedge accounting unless the volatility of the unhedgeable risk is insignificant relative to that of the hedgeable risk.

The large variation in potential hedge effectiveness across firm types is the major reason why hedge effectiveness usually fails to reveal the true nature of a derivative portfolio. For some firms, an 80% threshold is no match, for other firms it is simply not possible. Another explanation, albeit less important, is that the dichotomy of pure hedge and speculation is not the only possible decomposition of derivative holdings. What if firms deviate from the pure hedge for reasons other than speculation? Brown and Toft's optimal linear hedge may be seen as a combination of a pure hedge to minimize profit volatility and an adjustment that accounts for deadweight costs in various states of nature, necessary to maximize firm value. Consequently, we face two potential decompositions of derivative portfolios, yet any deviation from the pure hedge will decrease hedge effectiveness no matter the motivation for this deviation. The combined influence of these factors is that, under the current accounting regime, many valueable hedging programs will be incorrectly categorized as speculative and the frequency of miscategorization will not be uniform across firm types.

References

Aretz, K., & Bartram, S. M. (2010). Corporate hedging and shareholder value. *Journal of Financial Research, 33*(4), 317-371.

Bartram, S. M., Brown, G. W., & Fehle, F. R. (2009). International evidence on financial derivatives usage. *Financial Management, 38*(1), 185-206.

Berk, J., & DeMarzo, P. M. (2010). *Corporate Finance* (Second ed.): Pearson.

Bohrnstedt, G. W., & Golberger, A. S. (1969). On the exact covariance of products of random variables. *Journal of the American Statistical Association, 64*(328), 1439-1442.

Boze, K. M. (1990). Accounting for Options, Forwards and Futures Contracts. *Journal of Accounting, Auditing & Finance, 5*(4), 627-638.

Brown, G. W., & Toft, K. B. (2002). How Firms Should Hedge. *Review of Financial Studies, 15*(4), 1283-1324.

Charnes, J. M., Koch, P., & Berkman, H. (2003). Measuring Hedge Effectiveness for FAS 133 Compliance. *Journal of Applied Corporate Finance, 15*(4), 8-16.

Comiskey, E., & Mulford, C. W. (2008). The non-designation of derivatives as hedges for accounting purposes. *The Journal of Applied Research in Accounting and Finance, 3*(2), 3-16.

Ederington, L. H. (1979). The Hedging Performance of the New Futures Markets. *The Journal of Finance, 34*(1), 157-170.

Finnerty, J. D., & Grant, D. (2002). Alternative Approaches to Testing Hedge Effectiveness under SFAS No. 133. *Accounting Horizons, 16*(2), 95-108.

Froot, K. A., & Stein, J. C. (1993). Risk management: Coordinating corporate investment and financing policies. *Journal of Finance, 48*(5), 1629-1658.

Graham, J. R., Harvey, C. R., & Rajgopal, S. (2005). The economic implications of corporate financial reporting. *Journal of Accounting & Economics, 40*(1-3), 3-73.

Hailer, A. C., & Rump, S. M. (2005). Evaluation of hedge effectiveness tests. *Journal of Derivatives Accounting, 2*(1), 31-51.

Kalotay, A., & Abreo, L. (2001). Testing hedge effectiveness for FAS 133: The volatility reduction measure. *Journal of Applied Corporate Finance, 13*(4), 93-99.

Kanodia, C., Mukherji, A., Sapra, H., & Venugopalan, R. (2000). Hedge Disclosures, Future Prices, and Production Distortions. *Journal of Accounting Research, 38*(3), 53-82.

Kawaller, I. G., & Koch, P. D. (2000). Meeting the "Highly Effective Expectation" Criterion for Hedge Accounting. *Journal of Derivatives, 7*(4), 79-87.

Li, W., & Stammerjohan, W. (2005). Empirical Analysis of Effects of SFAS No.133 on Derivatives Use and Earnings Smoothing. *Journal of Derivatives Accounting, 2*(1), 15-30.

Lins, K. V., Servaes, H., & Tamayo, A. M. (2009). Does Fair Value Reporting Affect Risk Management? International Survey Evidence. *SSRN eLibrary*.

Nocco, B. W., & Stulz, R. (2006). Enterprise Risk Management: Theory and Practice. *Journal of Applied Corporate Finance, 18*(4), 8-20.

Penman, S. H. (2010). *Financial Statement Analysis and Security Valuation* (Fourth ed.): McGraw-Hill International Edition

Sapra, H. (2002). Do Mandatory Hedge Disclosures Discourage or Encourage Excessive Speculation? *Journal of Accounting Research, 40*(3), 933-964.

Sévi, B. (2006). Ederington's ratio with production flexibility. *Economics Bulletin, 7*(1), 1-8.

Smith, C. W. (2008). Managing corporate risk. *Chapter 18 in B. Espen Eckbo (ed.), Handbook of Corporate Finance: Empirical Corporate Finance, Volume II (Handbooks in Finance Series, Elsevier/North-Holland).*

Zhang, H. (2009). Effect of derivative accounting rules on corporate risk-management behavior. *Journal of Accounting and Economics*, *47*(3), 244-264.

Appendix. Cash flow variance with forward hedging under bivariate normality

Given that a firm's hedged net profits are defined as

$$\widetilde{np} = \left(\tilde{p} - s_1\right)\tilde{q} - s_2 + a\left(\tilde{p} - f\right), \tag{A.1}$$

the variance of the hedged profits is

$$\begin{aligned} \operatorname{var}\left(\widetilde{np}\right) = {} & \operatorname{var}\left(\tilde{p}\tilde{q}\right) + s_1^2 \operatorname{var}\left(\tilde{q}\right) + a^2 \operatorname{var}\left(\tilde{p}\right) \\ & - 2\, s_1 \operatorname{cov}\left(\tilde{p}\tilde{q}, \tilde{q}\right) + 2\, a \operatorname{cov}\left(\tilde{p}\tilde{q}, \tilde{p}\right) - 2\, a\, s_1 \operatorname{cov}\left(\tilde{p}, \tilde{q}\right) \end{aligned} \tag{A.2}$$

Following equation (6) in Bohrnstedt and Golberger (1969), the variance of a product of the two random variables $\tilde{p}$ and $\tilde{q}$ is

$$\operatorname{var}\left(\tilde{p}\tilde{q}\right) = \mu_{\tilde{p}}^2 \operatorname{var}\left(\tilde{q}\right) + \mu_{\tilde{q}}^2 \operatorname{var}\left(\tilde{p}\right) + 2\mu_{\tilde{p}}\mu_{\tilde{q}} \operatorname{cov}\left(\tilde{p}, \tilde{q}\right) + \operatorname{var}\left(\tilde{p}\right)\operatorname{var}\left(\tilde{q}\right) + \left(\operatorname{cov}\left(\tilde{p}, \tilde{q}\right)\right)^2 \tag{A.3}$$

Consistent with equation (13) in Bohrnstedt and Golberger (1969) for $u = 1$ and equation (8) in Sévi (2006), we may rewrite the first two covariance terms in equation (A.2) as follows:

$$\operatorname{cov}\left(\tilde{p}\tilde{q}, \tilde{q}\right) = \mu_{\tilde{p}} \operatorname{var}\left(\tilde{q}\right) + \mu_{\tilde{q}} \operatorname{cov}\left(\tilde{p}, \tilde{q}\right) \tag{A.4}$$

$$\operatorname{cov}(\tilde{p}\tilde{q},\tilde{p}) = \mu_{\tilde{q}} \operatorname{var}(\tilde{p}) + \mu_{\tilde{p}} \operatorname{cov}(\tilde{p},\tilde{q}) \tag{A.5}$$

Inserting for $\operatorname{var}(\tilde{p}\tilde{q})$, $\operatorname{cov}(\tilde{p}\tilde{q},\tilde{q})$, and $\operatorname{cov}(\tilde{p}\tilde{q},\tilde{p})$ from equations (A.3)-(A.5) in equation (A.2) yields the cash flow variance conditional on the choice of the number of (long) forward contracts, a:

$$\begin{aligned}\operatorname{var}\left(\widetilde{np}(a)\right) = {} & \mu_{\tilde{p}}^2 \operatorname{var}(\tilde{q}) + \mu_{\tilde{q}}^2 \operatorname{var}(\tilde{p}) + 2\mu_{\tilde{p}}\mu_{\tilde{q}} \operatorname{cov}(\tilde{p},\tilde{q}) + \operatorname{var}(\tilde{p})\operatorname{var}(\tilde{q}) + \left(\operatorname{cov}(\tilde{p},\tilde{q})\right)^2 + \\ & s_1^2 \operatorname{var}(\tilde{q}) + a^2 \operatorname{var}(\tilde{p}) - 2s_1\mu_{\tilde{p}} \operatorname{var}(\tilde{q}) - 2s_1\mu_{\tilde{q}} \operatorname{cov}(\tilde{p},\tilde{q}) \\ & + 2a\mu_{\tilde{q}} \operatorname{var}(\tilde{p}) + 2a\mu_{\tilde{p}} \operatorname{cov}(\tilde{p},\tilde{q}) - 2as_1 \operatorname{cov}(\tilde{p},\tilde{q})\end{aligned} \tag{A.6}$$

We may rewrite this expression as follows:

$$\begin{aligned}\operatorname{var}\left(\widetilde{np}(a)\right) = {} & \mu_{\tilde{p}}^2\sigma_{\tilde{q}}^2 + \mu_{\tilde{q}}^2\sigma_{\tilde{p}}^2 + 2\mu_{\tilde{p}}\mu_{\tilde{q}}\rho\sigma_{\tilde{q}}\sigma_{\tilde{p}} + \sigma_{\tilde{p}}^2\sigma_{\tilde{q}}^2 + \rho^2\sigma_{\tilde{q}}^2\sigma_{\tilde{p}}^2 \\ & + s_1^2\sigma_{\tilde{q}}^2 + a^2\sigma_{\tilde{p}}^2 - 2s_1\mu_{\tilde{p}}\sigma_{\tilde{q}}^2 - 2s_1\mu_{\tilde{q}}\rho\sigma_{\tilde{q}}\sigma_{\tilde{p}} \\ & + 2a\mu_{\tilde{q}}\sigma_{\tilde{p}}^2 + 2a\mu_{\tilde{p}}\rho\sigma_{\tilde{q}}\sigma_{\tilde{p}} - 2as_1\rho\sigma_{\tilde{q}}\sigma_{\tilde{p}}\end{aligned} \tag{A.7}$$

Setting $\mu_{\tilde{q}} = \mu_{\tilde{p}} = 1$, equation (A.7) may be reformulated as equation (A.8) below:

$$\begin{aligned}\left.\operatorname{var}\left(\widetilde{np}(a)\right)\right|_{\mu_{\tilde{p}}=\mu_{\tilde{q}}=1} = {} & \sigma_{\tilde{q}}^2\left(1-2s_1+s_1^2\right) + \sigma_{\tilde{p}}^2\left(1+2a+a^2\right) \\ & + \sigma_{\tilde{q}}^2\sigma_{\tilde{p}}^2\left(1+\rho^2\right) + 2\rho\sigma_{\tilde{q}}\sigma_{\tilde{p}}\left(1-s_1\right)\left(1+a\right) \qquad \square\end{aligned} \tag{A.8}$$