

# Meeting the “Highly Effective Expectation” Criterion for Hedge Accounting

IRA G. KAWALLER AND PAUL KOCH

**IRA G. KAWALLER** is founder of Kawaller & Company, LLC, a Brooklyn-based financial consulting practice that specializes in issues relating to derivative instruments. He is also a member of the Financial Accounting Standards Board's Derivatives Implementation Group (DIG).

**PAUL KOCH** is professor of finance at the University of Kansas.

*Financial Accounting Standard No. 133 (FAS 133), which takes effect for companies at the start of their fiscal years on or after June 30, 1999, specifies the accounting procedures applicable to derivative contracts. Derivatives are required to be recorded as assets or liabilities, measured at their fair values; in the general case, gains or losses are recorded in earnings. When derivatives are used for risk management purposes, special hedge accounting rules may be used, but this treatment is not automatic.*

*One of the prequalifying conditions for hedge accounting is that, in advance of the implementation of the hedge, the hedging entities must document the expectation that the hedge will be “highly effective.” Although FAS 133 authorizes the use of statistical techniques for this effectiveness testing requirement, no specific methodology has been endorsed.*

*This article addresses how such effectiveness tests should be structured. In the case of regression analysis, a number of questions come to mind. Should the analysis, for instance, use data on price levels or price changes? If it is correct to use price changes, what is the appropriate measurement interval (daily monthly, or quarterly)?*

*An exploration of these and other statistical questions leads us to conclude that regression results are useful as an indicator of hedge effectiveness only if appropriate data are used in the analysis. Moreover, we argue that the correlation coefficient, by itself, is an insufficient indicator of hedge performance, in that it relates to an “optimal” hedge, which may or*

*may not be precisely equal in size to the hedge that is actually intended. Several non-regression-based effectiveness testing methodologies do not suffer from these shortcomings.*

Qualifying for “hedge accounting treatment” is a virtual necessity for commercial entities that use derivative instruments for risk management purposes. This accounting treatment recognizes derivatives’ gains or losses in the same period as the income effects of the underlying hedged item. Otherwise, the mismatch in the timing of the income recognition presents a picture of income volatility that poorly reflects the underlying economics of the hedging activity.<sup>1</sup>

Unless the derivative is designated as a hedge under Financial Accounting Standard No. 133, gains or losses must be recorded in earnings. If a hedging relationship is specified, however, and if all the qualifying criteria are satisfied, the accounting treatment will be different, depending on the nature of the hedge. Three different types of hedges are permitted: fair value hedges, cash flow hedges, and hedges of net investments in foreign operations.

Fair value hedges apply to risks associated with the price of an asset, liability, or firm commitment. The carrying value of the item being hedged (i.e., the asset, liability, or firm commitment) is adjusted to reflect the change in its market value due to the risk being

hedged, and this change is posted to earnings. Corresponding gains or losses on the derivative used to hedge this risk are also posted to earnings, just as they are for non-hedge derivatives applications.

A hedge of an upcoming forecasted event is a cash flow hedge. For cash flow hedges, derivatives results must be evaluated, and a determination made as to how much of the result is “effective” and how much is “ineffective.” The ineffective component of the hedge results must be realized in current income, while the effective portion originally is posted to “other comprehensive income” and later is reclassified as income in the same period in which the forecasted cash flow affects earnings. The Financial Accounting Standards Board recognizes hedges as ineffective for accounting purposes only when the hedge effects exceed the effects of the underlying forecasted cash flow, measured on a cumulative basis.

Finally, there are hedges associated with the currency exposure of a net investment in a foreign operation. Again, the hedge must be marked to market. This time, the treatment requires effective hedge results to be consolidated with the translation adjustment in other comprehensive income. Differences between total hedge results and the translation adjustment being hedged flow through earnings.

It is not sufficient merely to elect to apply hedge accounting. Instead, FAS 133 reflects a philosophy that hedge accounting is “special,” and it is justified only if specific prerequisites are satisfied. At the top of the list of requirements is *ex ante* documentation supporting the expectation that the hedge will be “highly effective.”

While it stipulates the need to document this expectation, the FASB has left the methodology for doing so to the discretion of the hedger. As a consequence, many prospective hedgers are uncertain about precisely how to satisfy this requirement.

This article is designed to address this concern. We explain the notion of hedge effectiveness in the context of FAS 133. We detail common shortcomings associated with the use of regression analysis in measuring hedge effectiveness, and we suggest ways these shortcomings may be resolved.

## I. THE “HIGHLY EFFECTIVE EXPECTATION” CRITERION

Simply knowing that the economic objective of the hedge will be realized may not be sufficient to qualify for hedge accounting treatment. Rather, FASB requires that

those who want hedge accounting treatment must document that their hedges will be highly effective *at offsetting changes in fair values or changes in the expected cash flows of the associated exposures that are due to the risk being hedged.* Documentation is required at or before the time at which the derivatives transaction is designated as a hedge.

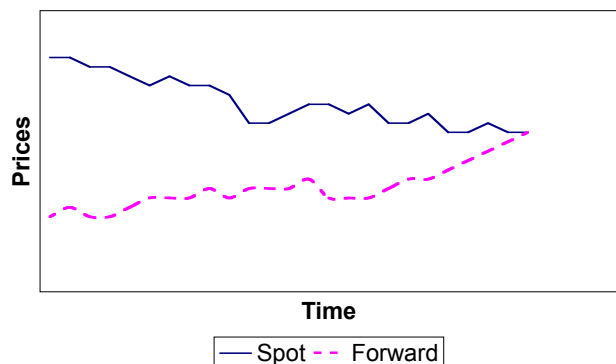
While never explicitly required in FAS 133, a widely used reference for any discussion of effectiveness is the 80-120 standard. Under this standard, hedges would qualify for hedge accounting only if the results from the derivative were expected to correspond to no less than 80% and no more than 120% of the associated changes of the item being hedged.<sup>2</sup> Unfortunately, this rule suffers from the rather significant shortcoming that it will likely disqualify hedge accounting for very traditional derivatives used in plain vanilla hedging applications.<sup>3</sup>

For example, suppose a hedger sells a forward contract on an available-for-sale security. Short of bankruptcy on the part of the counterparty to the forward contract, the forward price *will* be the realized sale price of the security in question. It may not be effective, however, in offsetting the *change in the spot price* of that security. In fact, to the extent that spot and forward prices differ at the inception of a hedge, the two price changes are necessarily not equal over the life of the hedge.

An extreme example of this “ineffectiveness” is seen in Exhibit 1. Here, the forward price relevant to a particular value date initially is at a discount to the spot price. A short forward position is taken to hedge ownership in the underlying asset. In the scenario depicted, by the time this forward value date arrives (i.e., when the spot and forward price converge), the spot price falls. Over the

### EXHIBIT 1

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same time, however, the forward price moves higher. Rather than offsetting the change in the spot price, then, the short forward position actually reinforces the detrimental price effect.

Options pose a problem as well. An option's price changes in variable proportion to the price of the instrument underlying the option. For deep out-of-the-money options, the proportionality factor is near zero; for at-the-money options it's 50%; and for deep-in-the-money options it approaches 100%. This property of option contracts means that, in the short run, option prices should be expected to change by *less than* the prices of their underlying instruments. Thus, except when the option is deep in the money, one should not expect options to provide an effective offset to the change in fair value or the change in the expected cash flow of the hedged item.<sup>4</sup>

Do these complications mean that users of options are precluded from using hedge accounting because the "highly effective" expectation criterion cannot be satisfied?

In fact, the FASB created safety valves for both of these cases. Users of forward contracts may elect to exclude the forward premium or discount from the hedge effectiveness consideration.<sup>5</sup> And, with respect to options, the test of effectiveness may be based solely on changes in the option's intrinsic value. To put it another way, changes in the time value of the option may be excluded from the effectiveness consideration.<sup>6</sup>

While such solutions preserve the capacity to employ hedge accounting, they do so at a cost. When hedgers elect to exclude any component of a derivative's result from the consideration of hedge effectiveness, FASB requires that excluded portion of the derivatives' gain or loss to be recognized in current earnings. Thus, with such an election, at least some degree of income volatility will result — even when the economic intentions of the hedge are perfectly realized. And critically, depending on the specifics of the hedge, these anticipated effects may turn out to be substantial enough to influence the choice of the hedging instrument, or even the decision to hedge altogether.

Any documentation relating to hedge effectiveness should compare the *non-excluded* portion of the derivative's results to the changes in the fair value or the changes in the expected cash flows of the hedged item due to the risk being hedged. Constructing a statistical test for this purpose may not be a trivial task.

## II. PITFALLS OF REGRESSION ANALYSIS

While FAS 133 authorizes the use of regression analysis for hedge effectiveness testing and assessment, it leaves open the question of precisely how this analysis should be performed. To illustrate the typical usage, consider a simple time series regression of  $y$  on  $x$ , where  $y$  is the price variable associated with the hedged item, and  $x$  is the price variable associated with the hedging instrument. This regression results in the equation:

$$y = \alpha + \beta x + \varepsilon \quad (1)$$

where the regression coefficient,  $\beta$ , measures the sensitivity of  $y$  to  $x$  over the sample period and represents the "optimal hedge" ratio.<sup>7</sup>

The  $R^2$  statistic for this simple regression is the square of the correlation between  $x$  and  $y$ . It represents the extent to which high (low) values of  $y$  are associated with high (low) values of  $x$ . This goodness of fit statistic therefore offers one measure of the effectiveness of the "optimal hedge" over the sample period investigated. Presumably a higher  $R^2$  would lead to greater confidence that the "optimal hedge" will be highly effective.<sup>8</sup>

It is noteworthy that this  $R^2$  is appropriate only to measure the effectiveness of the "optimal hedge" (i.e., only if the regression coefficient is used as the hedge ratio). Use of a different hedge ratio would imply a relation between the hedge actually employed and the hedged item that deviates from the fitted line. Because the  $R^2$  of this simple regression (or the correlation between  $x$  and  $y$ ) is independent of scale, it is insufficient to measure the effectiveness of all possible hedges (i.e., hedge ratios) that employ the hedging instrument,  $x$ , to hedge an exposure,  $y$ . More on this issue later.

A more immediate concern is whether the regression should be applied to price *levels* or price *changes*. If  $x$  and  $y$  are price levels, the resulting  $R^2$  gives the square of the correlation between levels. If  $x$  and  $y$  are price *changes*, the  $R^2$  gives the square of the correlation between *changes*. Given the explicit FAS 133 requirement that the hedge result should offset the changes in fair values or changes in cash flows, it might seem that *changes* would be the preferred answer. But regression results based on this selection could be misleading.

We consider two different cases. In the first case, suppose the price associated with the hedging instrument oscillates about a constant mean on a daily basis, and the price of the hedged item exhibits analogous up-down movements but centered around a rising trend (see Exhibit 2). In this case, the two respective price levels are uncor-

related, but the daily price changes exhibit *perfect* correlation. Thus, regression analysis performed on price levels would suggest that the hedge will *not* be effective. Yet reliance on the correlation of price changes gives the impression that the hedge will work perfectly (i.e., an  $R^2$  equal to 1.0), when it most certainly will not.

In the second case, assume both the hedging instrument and the hedged item exhibit consistent trends, but one series varies randomly from this trend, while the other series exhibits a sawtooth pattern about the same trend (as per Exhibit 2). Price changes would be uncorrelated (low  $R^2$  for changes), while price levels would be highly correlated.

In both these cases, the  $R^2$ s associated with price levels lead to “correct” conclusions (i.e., that the first hedge would not be effective, while the second hedge would). Reliance on  $R^2$ s based on price changes, on the other hand, would lead to exactly the opposite conclusions.

This discussion might suggest that the appropriate indicator of hedge effectiveness should be the correlation of price *levels*, as opposed to price *changes*, but this conclusion is similarly flawed. The statement that two price levels are highly correlated does not necessarily imply a reliable relationship between their price *changes* over a particular hedge horizon, which is the issue of concern for the FASB.

Consider the case of two stock indexes that are known to be highly correlated over the long run (e.g., growth stock prices and value stock prices). Despite the

high correlation associated with price levels of these two indexes, history reveals extended periods over which their price changes have differed markedly.<sup>9</sup>

### III. CONSTRUCTING APPROPRIATE DATASETS FOR TESTING HEDGE EFFECTIVENESS

Our major point is that regression analysis can reliably be used in connection with hedge effectiveness testing and validation, but only if the appropriate data are employed in the effort. A properly designed calculation of the  $R^2$  statistic should examine the relation between *changes* in the value of the hedging instrument and the asset to be hedged, *where changes are measured over a horizon consistent with the timing of the prospective event being hedged.*

More explicitly, an appropriate test should assess whether the non-excluded gain or loss on the derivative will closely approximate the desired change in fair value or change in expected cash flows of the hedged item over the hedge horizon. If the length of time to the hedge value date is one year, one should collect past observations reflecting changes in the value of the two assets over one-year periods; if the hedge horizon is three months, the data should reflect three-month periods, and so on.

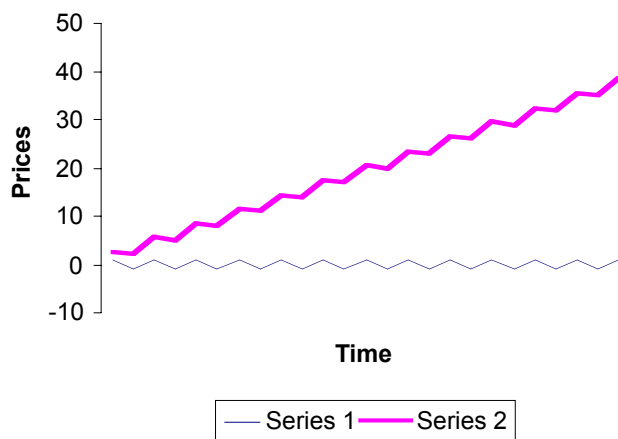
Unfortunately, implementing this preferred approach may present substantial practical problems. First, there may be insufficient data to conduct a reliable statistical analysis using the preferred approach. For example, if the hedge horizon were twelve months and one wishes to use one hundred observations in the analysis, this would require data from one hundred years.<sup>10</sup>

Second, hedge horizons are not universally constant or stable over time. For example, consider the typical cash flow hedge for some forecasted event with a given hedge value date. As time passes, the hedge value date approaches, and the hedge horizon shortens. Thus, the hedge horizon is a constantly moving target. Presumably, the preferred test to validate the expectation of high effectiveness at the inception of the hedge would differ from the test (if required) to “revalidate” the expectation at a later date.<sup>11</sup>

While it is clearly correct (and appropriate) to match the data on price changes with the hedge horizon, as directed above, this approach is not necessarily the only way to accommodate FAS 133. As a practical matter, it may be more manageable to use quarterly price changes as a standard time frame for effectiveness testing. This approach would reflect the objective of assessing

## EXHIBIT 2

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hedge effectiveness over a single accounting period (i.e., a quarter of a year), regardless of the actual period of each individual risk exposure in the user's overall portfolio.<sup>12</sup>

Using price changes measured over shorter periods than a quarter, however, would *not* be appropriate. Indeed, use of price changes over a shorter span than quarterly is likely to be misleading. Conducting a regression with data reflecting daily price changes, for example, would be useful only in assessing the performance of a hedge that has a single-day hedge horizon. "Success" or "failure" over one-day periods gives no reliable indication about the viability of hedges with longer horizons.

To put it another way, demonstrating that two series of daily price changes are highly correlated does not necessarily mean that high correlation would also be found over a longer period. Conversely, just because daily price changes are *not* highly correlated, the same lack of correlation may not hold for a longer period.

This concern about time spans for price changes holds for both traditional regression analysis as well as for more sophisticated techniques such as value at risk (VaR) or Monte Carlo simulations. In each case, the conclusions that follow from the analysis are strictly relevant to the time horizon that applies to the data used in the investigation. Unfortunately, the need to use either quarterly price changes or price changes measured over the same time frame as the hedge horizon is common to any method of statistical analysis.

#### IV. OVERLAPPING TIME INTERVALS

It is interesting to explore whether overlapping samples may be used to assess hedge effectiveness. That is, if the hedge horizon is three months, and one wants to use one hundred observations in the analysis, is it necessary to collect data from one hundred quarters (i.e., go back twenty-five years)? Alternatively, can overlapping periods be used when data extend back only a few quarters?<sup>13</sup>

To elaborate, suppose the hedge horizon is one quarter and  $N$  observations are available on quarterly changes in the value of the asset to be hedged ( $y_T - y_{T-1}$ ) and the value of the hedging instrument ( $x_T - x_{T-1}$ ). If the sample size is sufficient, one could estimate a regression model to obtain evidence about whether the hedge will be effective:

$$(y_T - y_{T-1}) = \alpha + \beta(x_T - x_{T-1}) + \varepsilon_T \quad (2)$$

where  $T = 1, \dots, N$  non-overlapping quarterly observations. A high  $R^2$  would then support the expectation of highly effective hedge performance.

If there are not enough non-overlapping quarterly observations to conduct a reliable regression analysis, one would need to consider alternative means for measuring hedge effectiveness. One logical approach would be to incorporate higher-frequency data, yet retain the one-quarter time interval for price changes by using overlapping data.

For example, suppose quarterly price changes are available on a daily basis for  $N$  quarters. Then the regression model could be:

$$(y_t - y_{t-91}) = \alpha + \beta(x_t - x_{t-91}) + \eta_t \quad (3)$$

where  $t = 1, \dots, j \times N$  overlapping daily observations on quarterly price changes,  $j$  = the number of daily observations per quarter, and  $N$  = the number of quarters of daily data available.

Note that quarterly changes are measured here as the differences in data on  $x_t$  or  $y_t$ , ninety-one days apart. The approach in Equation (2) ignores the information in  $x_t$  and  $y_t$  during the ninety days between each non-overlapping quarterly observation, while the approach in Equation (3) incorporates this information. This information is useful to gain efficiency in estimating the nature of the hedging relation between quarterly changes in  $x_t$  and  $y_t$  over time.

Unfortunately, the latter approach has a shortcoming that requires attention. Such overlapping samples are not independent across time. They tend to be more highly autocorrelated than the non-overlapping quarterly differences in the daily data.

In the general case, we would expect the overlapping data on  $(x_t - x_{t-91})$  and  $(y_t - y_{t-91})$  to follow ninety-one-day moving averages. This means that, in an important sense, six months of daily data on  $(x_t - x_{t-91})$  and  $(y_t - y_{t-91})$  may not really provide much more information than two independent three-month observations.

This inertia in the ninety-one-day differences will tend to induce autocorrelated errors ( $\eta_t$ ) in Equation (3). That is, overlapping data in the ninety-one-day differences,  $(x_t - x_{t-91})$  and  $(y_t - y_{t-91})$ , imply overlapping errors ( $\eta_t$ ) as well. In this example, we would generally expect  $\eta_t$  to be represented as a moving average of order ninety-one lags, similar to the overlapping data on  $(x_t - x_{t-91})$  and  $(y_t - y_{t-91})$ .

Studies based on overlapping data require formal statistical techniques to adjust the standard errors of the

estimated coefficients for non-independence of the error terms (see Newey and West [1987] and Hansen [1982]). This adjustment allows for reliable statistical testing of the ordinary least squares (OLS) coefficient estimates that characterize the hedging relationship (see Greene [2000] for details).<sup>14</sup>

## V. ALTERNATIVE APPROACHES TO MEASURE HEDGE EFFECTIVENESS

It is important to emphasize that the  $R^2$  measure from either Equation (2) or Equation (3) provides relevant information regarding the effectiveness of the “optimal hedge.” It does not, however, directly document the performance of the actual *combined position* taken by the user (inclusive of the hedged item and the hedging instrument) relative to the hedged item by itself, in accord with FAS 133. Furthermore, while FAS 133 specifically refers to regression analysis, it also provides the latitude to use other statistically based methodologies.

An alternative approach is to focus on the combined position and to frame the discussion in a manner that is more consistent with a value at risk orientation. We offer four alternatives for consideration.

### Alternative Method 1

One could directly compare past changes in the value of the combined position [labeled  $(c_T - c_{T-1})$ ] with changes in the hedged item in isolation  $(y_T - y_{T-1})$ . In this framework, a hedge would be deemed highly effective if the variance of the combined position were substantially smaller than the variance of the hedged item by itself.

Statistically, this assessment could be made as follows:

1. Select a historical sample.
2. Collect data on changes in the value of the hedged item  $(y_T - y_{T-1})$  and the combined position  $(c_T - c_{T-1})$ , covering time periods commensurate with the duration of the hedge.<sup>15</sup>
3. Calculate the variance of the hedged item  $(V_y)$  and the variance of the combined position  $(V_c)$ .
4. Set some threshold of acceptability (T) such that, if  $V_c/V_y < T$ , the “highly effective” criterion is said to be satisfied.<sup>16</sup>

### Alternative Method 2

In order to qualify for hedge accounting, the combined position of the hedged item and the derivative must result in a gain or loss over the accounting period that is constrained to be within a small fraction of the initial value of the hedged item, with a high level of confidence. It is left to the discretion of the client to specify the critical parameter values for this method.

For instance, the changes in the initial fair value or cash flow of the exposed item, combined with the gain or loss on the derivative, should be less than some set percentage of the original value of the hedged item, at a 95% level of confidence.<sup>17</sup>

### Alternative Method 3

This method justifies the expectation of high effectiveness through scenario analysis. A boundary condition must be stipulated, relating to the prospective quarterly change in value of the combined position relative to the initial value of the hedged item. The highly effective criterion would be satisfied if this boundary condition were violated in only some small fraction of the scenarios (constructed to include a realistic mix of both extreme market moves and stable conditions).

### Alternative Method 4

This method divides historical quarterly changes in the value of the hedged item into subsamples reflecting varying degrees of variability. Within each subsample, a boundary condition would be specified pertaining to the ratio of the change in the combined position, relative to the initial value of the hedged item. Hedges would then be expected to be highly effective if this boundary condition were violated in a low percentage of the historical observations.

If this fourth method is selected, the user would need to designate:

1. An algorithm for segmenting the historical observations of changes in the value of the hedged item.
2. Boundary conditions relevant to each segmentation.
3. The critical threshold or the percentage observations for which the boundary conditions must be satisfied.

For example, one might choose to partition the historical price changes for the hedged item into three subsamples: those where  $(y_T - y_{T-1})$  is greater than two

standard deviations, a second where  $(y_T - y_{T-1})$  falls between one and two standard deviations (inclusive), and a third where  $(y_T - y_{T-1})$  is smaller than one standard deviation. Rather than imposing a simple proportion of the original value of  $y$  as the threshold condition (as per alternative method 1 or 2), the user might want to specify a set of graduated thresholds that vary directly with the magnitude of the value change of the hedged item.

For instance, the boundary conditions might be that the combined results from the derivative and the hedged item should be smaller than: 1) 20% of three standard deviations in the first segmentation, 2) 20% of two standard deviations in the second, and 3) 20% of one standard deviation in the third. Assuming these conditions are not violated in, say, 95% of all observations, the hedge relationship would satisfy the “highly effective” expectation test.

In a substantial number of cases, the variable underlying the derivative will exactly match the hedged item’s risk variable, and, assuming the hedge is appropriately sized, no formal *ex ante* statistical tests would be required under FAS 133.<sup>18</sup> In this case, if a statistical test were performed — whether the relevant frequency of the data were one quarter, one year, five years, or whatever — the  $R^2$  of the appropriate regression model would be one, reflecting the fact that the analysis would effectively compare a data series with itself.

Alternatively, when the two respective prices or variables are *not* identical (e.g., when there is a cross-hedge or a quality or location difference between the two), any of the other methods for testing hedge effectiveness would be a reasonable approach.

## VI. CONCLUSIONS

The prerequisite for hedge accounting treatment that requires up-front documentation to support the expectation that any given hedge will, in fact, be highly effective is one of the more problematic features of FAS 133. The difficulty is fourfold:

1. “Effectiveness” is defined by the standard in a manner that may frequently be at odds with the economic objective of the hedge in question.
2. The ubiquitous 80-120 offset ratio standard is recognized as deficient, in that it generates misleading indications of ineffectiveness when hedges may be working well in an economic sense.
3. Despite the limitations of the 80-120 standard,

the FASB has not offered any alternative guidance regarding how to satisfy its requirement to assess hedge effectiveness.

4. Even if explicit methodologies were to be endorsed, unless appropriate data are accessible and used — including a sufficient number of observations to conduct reasonable analysis — results of these tests will not be reliable.

To elaborate on the last issue, the FASB allows use of regression analysis to test hedge effectiveness, but beyond stating that hedge effectiveness may be assessed either on a period-by-period basis or on a cumulative basis, the Board is vague on specifics. Regression analysis is reliable only if the model is specified properly and appropriate data are employed. If a period-by-period assessment is selected, quarterly price change data should be used in the analysis; if a cumulative assessment is desired, price changes should reflect the span of the hedge horizon. Use of overnight price changes, however, would have no merit in either case.

With respect to the issue of data limitations, the question of whether or how to use overlapping observations is particularly pressing. Overlapping samples may enhance the ability of the researcher to uncover the relationship desired, and in some cases may even make the statistical analysis possible. Efficiency in estimation can be improved because overlapping observations allow the time series properties of the finely sampled data to be incorporated into the analysis.

The disadvantage is that overlapping observations on higher-frequency data induce autocorrelation in the regression error term. Although this problem may be resolved by using the methodology of Hansen [1982] or Newey-West [1987] to correct the standard errors of the OLS estimates for the presence of autocorrelated errors, these methods do not work well when the degree of overlap is large relative to the sample size.

Despite these problems, FAS 133 demands that potential hedgers must do *something* in connection with effectiveness testing. Many will end up doing the wrong thing. Almost every corporate desktop has access to statistical tools for regression analysis or correlation calculations, but an inappropriately specified statistical test offers no better information than no test at all. Indeed, the wrong statistical analysis should be viewed with less favor than no analysis, since the user of inaccurate analysis will have misconceptions regarding the expected outcome.

Unfortunately, without the requisite level of sta-

tistical expertise, it seems likely that much of the analysis performed in order to justify hedge accounting will be of poor quality.

## ENDNOTES

The authors thank Henk Berkman, Michael Dorigan, Andrew Kalotay, Don Lien, and Jun Yu for helpful comments.

<sup>1</sup>To be consistent with the language in FAS 133, the text refers to the “hedged item” as the instrument that is responsible for the exposure or risk under consideration, and the “hedging instrument” is the derivative used in a “hedging relationship.”

<sup>2</sup>Some accounting firms have promulgated an 80%-125% tolerance band, reflecting the fact that the ratio of 100/80 is 125%.

<sup>3</sup>Canabarro [1999] offers evidence that, even when two series reflect a correlation of 98%, the ratio of derivatives results to changes in the value of the hedged item can be expected to be outside the 0.80-1.25 range in 46.9% of the quarters in the sample.

<sup>4</sup>The effectiveness of hedging using options is further complicated by the fact that the option’s extrinsic/time value is sensitive to other factors besides the value of the underlying asset. That is, in addition to the delta, the hedger must also consider gamma, vega, theta, and rho. See Hull [1998] for details.

<sup>5</sup>The FASB explicitly authorizes effectiveness to be measured with reference to changes in either the spot price or the forward price of the hedged item. See Paragraph 65 of FAS 133.

<sup>6</sup>This election would be appropriate only for a static hedging strategy (i.e., if the hedger intends to hold an option position over the entire hedge horizon). Dynamic (delta-) hedging strategies would necessarily involve the time value of the option as well as its intrinsic value.

FAS 133 specifies the terminology of an option’s “volatility value” and “minimum value” (Paragraph 63). The minimum value of an option is the present value of the intrinsic value of a European option (i.e., the amount that could be immediately monetized); and the volatility value is the difference between the full price of the option and the minimum value. If a European option is used as a hedge, it would likely be advantageous to exclude the volatility value (rather than the time value) from the effectiveness consideration.

<sup>7</sup>An “optimal hedge” is defined as one that employs a position in the hedging instrument that minimizes the variance (the sum of squares) of the regression error terms (see Hull [1998]). Kawaller [1992] points out, however, that a minimum-variance hedge ratio may not be “optimal” in terms of satisfying the economic objectives of the hedger.

<sup>8</sup>It is left to the discretion of the entity employing the effectiveness test to specify the critical threshold for the  $R^2$  that

permits the assumption of “high effectiveness.” The FASB has studiously avoided providing any specific guidance in this regard.

<sup>9</sup>This disparity was particularly great in 1999.

<sup>10</sup>Even when data are available with sufficient sample size, if some structural change occurs over the period spanned by the data, earlier observations might not be reliable for making inferences about the future hedge horizon, as they may not be representative of current market relationships.

In some cases, the desired data are not available for *any* time span. For example, if the hedger wants to use an interest rate swap to hedge a non-rated corporate bond issue, daily prices (i.e., fixed rates) for the swap can be accessed through a number of data vendors. The same is not true, however, for data on this particular bond. The lack of data may force the analyst to fabricate a dataset by hypothesizing or creating the required data from available actual data. Then, using these fabricated data, the analyst is asked to document that a “highly effective” standard will likely be met.

<sup>11</sup>An interesting example of this problem involves the “passage of time” when hedging interest rate exposure. It is inappropriate to measure changes in a constant-maturity instrument when the maturity of the instrument in question is diminishing over time. For example, to assess the prospective effectiveness of a five-year swap used to hedge a five-year bond, the appropriate value changes are associated with differences between four and three-quarter-year instruments at the end of the quarter, versus five-year instruments at the beginning of the quarter.

<sup>12</sup>The FASB’s Derivatives Implementation Group has suggested that quarterly price changes would be the preferred methodology. See “Basing the Expectation of Highly Effective Offset on a Shorter Period than the Life of the Derivative,” which was cleared by the board on November 23, 1999.

<sup>13</sup>This issue has been addressed in the literature on multiyear asset returns and term structure premiums (Campbell and Shiller [1991]), and on regulation of derivatives usage in hedge accounting (Wong [2000]). Richardson and Smith [1991] provide an extensive discussion of the econometric problems involved in using overlapping data to analyze financial relationships.

<sup>14</sup>It is noteworthy that, while such econometric methods are available to correct regression standard errors for overlap, they do not work well when the degree of overlap is large relative to the sample size (i.e., when  $j$  is large relative to  $j \times N$ ). That is, if a smaller number of quarters worth of daily data were available, one would place less credence in the results of this exercise. Still, this methodology may provide the best approach available to achieve the goals of the analysis.

These econometric issues pertain to the standard error of the OLS estimate of  $\beta$ , rather than to the estimate of  $\beta$  itself. The OLS estimate of  $\beta$  is still BLUE (best linear unbiased estimator), and is critical to the question of the *size* of the optimal

hedge position (e.g., the notional value of a swap position or the number of futures contracts in the hedge). Furthermore, the issue of autocorrelated errors in Equation (3) is not directly relevant to the magnitude of the correlation between  $(x_t - x_{t-91})$  and  $(y_t - y_{t-91})$ , or, equivalently, the  $R^2$  for this regression model.

<sup>15</sup>The same question of whether these data can or should be overlapping or non-overlapping applies in this approach, just as it does with traditional regression analysis.

<sup>16</sup>Note that the variance of the combined hedged position,  $V_c$ , represents variation in the hedged item that is not accounted for by the hedge selected. Thus,  $V_c$  is analogous to the sum of squared residuals (SSE) in a regression model, while  $V_y$  represents the total variation in the hedged item (SST). Hence,  $V_c/V_y$  can be thought of as the proportion of the total variance (or risk) that is *not* eliminated by hedging. Accordingly,  $(1 - V_c/V_y)$  is the proportion of the risk that *is* eliminated by hedging, and is analogous to  $(1 - SSE/SST)$ , which is the  $R^2$  of a regression model (Greene [2000, pp. 236-242]). A smaller ratio,  $V_c/V_y$ , therefore corresponds to a higher regression  $R^2$ , and signals the expectation of a more effective hedge.

<sup>17</sup>The choice of a threshold criterion ought to be set on a market-by-market basis. For instance, if hedging bonds, where the unhedged price change might be expected to be within, say, 5% of the initial value of the bonds with a high degree of confidence, the choice of a 1% or 2% threshold might be deemed to be reasonable. If the exposure is to the price of crude oil, where unhedged price effects have a history of being much more severe, a threshold of 5% or 10% might be more appropriate.

<sup>18</sup>This conclusion presumes that if the derivative instrument is an option, its time value (or volatility value) is excluded from the hedge effectiveness consideration; or, if the derivative is a forward (or futures) contract, the spot/forward differential is excluded from the hedge effectiveness consideration.

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