The Problem with Current Accounting: A Critique of SFAS 115 and SFAS 133 Using an Equity-Indexed Annuity Example

Marsha Wallace*

Abstract

In recent decades, as the use of derivatives by financial institutions has expanded, the shortcomings of historical cost accounting approaches have become increasingly apparent. Since derivatives can create large exposures to risk that go unnoticed under historical standards, the accounting industry has focused on how to change the standards so that these risks are reflected appropriately in a company's accounting statements. New standards such as SFAS 115 and SFAS 133 have been adopted in part to achieve this goal. However, both of these standards use a piecemeal approach to risk measurement that may be adding to the problem rather than creating a solution. This paper will use a simple equity-indexed annuity to illustrate the problem with historical cost accounting and with the standards that have been adopted to correct it. The paper then argues that the only legitimate means of reflecting risk properly on a company's accounting statements is to adopt full fair value accounting for all assets and liabilities on the company's books.

The paper begins with a short analysis of the proper method to measure economic risk associated with a liability and the assets backing the liability. It then describes how this ''economic'' approach for measuring assets and liabilities differs from the historical cost accounting approach.

Section 2 breaks an equity-indexed annuity product into two components: (1) a fixed-rate bond and (2) an equity call option. The assets that establish a perfect hedge for this product are also identified. The economic risk is shown to be zero if the company that issued the annuity holds the hedge assets, and nonzero if the company does not hold the hedge assets.

Section 3 illustrates the problems that result when the equity-indexed annuity is accounted for under a historical cost approach. Specifically, the historical cost approach shows there is no risk in the portfolio of assets and liabilities described above whether this is the case or not (at least in the short term).

Section 4 describes the changes that were made to the historical accounting standards as a consequence of adopting SFAS 115.[1] The treatment of the equity-indexed annuity (and associated assets) under this standard is described. Specifically, the SFAS 115 approach to risk measurement may show a significant change in the value of the portfolio of assets and liabilities whether this has occurred or not.

Section 5 describes the changes that were made to the historical accounting standards as a consequence of adopting SFAS 133.[2] The treatment of the equity-indexed annuity (and associated assets) under this new standard also is described. Again, it is demonstrated that risk measurement under SFAS 133 does not show the risk in the portfolio appropriately.

* Marsha Wallace, CFA, is President of World Wide Asset Liability Management, 12011 Weddington St., Valley Village, CA 91607, wallacemarsha@msn.com.

[1] SFAS 115, ''Accounting for Certain Investments in Debt and Equity Securities,'' was adopted by the FASB in 1993.

[2] SFAS 133, ''Accounting for Derivative Instruments and Hedging Activities,'' was adopted by the FASB in 1998. The effective date of this standard was deferred by SFAS 137, ''Accounting for Derivative Instruments and Hedging Activites: Deferral of the Effective Date of SFAS #133,'' which was adopted in 1999.

Section 6 explains what would happen if the equity-indexed annuity (and associated assets) were accounted for under a full fair value system. This explanation demonstrates that a full fair value approach does show the economic risks of the assets and liabilities appropriately whether the product is being hedged or not.

The paper concludes that the goal of showing a company's economic risk appropriately can be reached only by adopting a system of full fair value accounting for all assets and liabilities. Furthermore, this section argues that the risks associated with financial assets and liabilities will not be managed appropriately until these risks are reported in the accounting numbers using full fair value measures.

1. SHORT ANALYSIS OF THE PROPER METHOD TO MEASURE ECONOMIC RISK

A commonly accepted goal of corporate management is to increase the value of the corporation over time (Copeland, Koller, and Murrin 2000). More specifically, the goal of corporate management is to increase the market value of the company's stock (or surplus) for any given level of assumed risk (see, e.g., Griffin and Boomgaardt 1999).

Thus, the ''economic'' value of a company is the market value of the company's stock. The ''economic'' risk for the same company is determined by the distribution of possible market values of the company's stock around the expected value (Sharpe 1985). A company is said to have no economic risk if only one value is possible for market value of surplus at any point in time regardless of market conditions.

In a previous paper, I have noted that market value of surplus can be determined in two ways (Wallace 2000):[3]

1. Market Value of Surplus =
   Market Value of Assets − Market (or Fair) Value of Liabilities = PV (asset cash flows) − PV (liability cash flows)
2. Market Value of Surplus =
   PV of net cash flows = PV (asset cash flows − liability cash flows).[4]

However, both of these methods should produce the same value if the discount rates that are used to determine the present values are derived appropriately and other assumptions are consistent as well. (See Appendix B for a further discussion of this issue.)[5]

The implication of the above statement is that a company should measure the change in the value of its surplus using market value measures for assets and liabilities whether it follows a ''buy and hold'' strategy or trades its assets and uses the proceeds to settle its liabilities immediately.[6] In the first case (a ''buy and hold'' strategy), the company's earnings will emerge over time in the form of net cash flows from assets minus liabilities, and so the value of the company should be measured as the present value of this net cash-flow stream (i.e., using method 2 above). In the second case (a strategy of selling assets and settling liabilities), the company will receive the market value of the assets at the time of sale and will deduct the cost of settling the liabilities with net proceeds going to the shareholders. Thus the value in this case will be based on method 1 above, but the value in both cases will be the same. So, in either case, the relevant measures of economic value are the market (or fair) values of the assets, liabilities, and surplus.

Given this conclusion, it is clear that a balance sheet showing the economic value of a company's

[3] A mathematical representation of these two approaches is provided in Appendix A.

[4] ''Asset cash flows'' in both of these equations are net of any reinvestments in additional securities and include any cash flows from reinvested assets purchased previously. ''Liability cash flows'' in both equations include payments to long-term debt. The second equation for MVS is a reduction from the more generalized equation:
Market Value of Surplus = PV (asset cash flows − liability cash flows − free cash flow reinvested by the company), where the last term in parentheses is assumed to be 0 for simplicity. Effectively, this equation is the equivalent of PV (free cash flows to shareholders), but in an insurance company context.

[5] Where options are present, market values under both methods will have to be calculated over a range of stochastic scenarios, but the equivalence of the two methods still will hold in each scenario. Therefore, the implications that follow can be generalized to the case where options are present.

[6] An alternative proof of the equivalence of the value of the firm under a ''buy and hold'' strategy and a ''trade and settle'' strategy is provided in Girard (2000).

assets, liabilities, and surplus would use market-based measures for these values regardless of its trading intentions. But what would be shown on the company's "economic" income statement?

Since the income statement is intended to show the change in the values on the balance sheet from period to period (Welsch and Anthony 1974), an economic income statement should measure the following:[7]

Change in Asset Value = $MVA_{n+1} - MVA_n$ = Change in Market Value of Assets during the Period = Total Return on Assets during the Period

Change in Liability Value = $FVL_{n+1} - FVL_n$ = Change in Market (or Fair) Value of Liabilities during the Period = Total Return on Liabilities during the Period

Change in Surplus Value = $MVS_{n+1} - MVS_n$ = Change in Market Value of Surplus during the Period = Total Return on Surplus during the Period = Total Return on Assets − Total Return on Liabilities during the Period.

Furthermore, the total return measures above can be broken into the following three components (Wallace 2000):

Total Return = Income + Realized Gains + Unrealized Gains.

Therefore, an income statement that properly measures the economic risk in a company's surplus should measure the change in surplus value as follows, regardless of a company's trading intentions:

Change in Surplus = Total Return on Assets − Total Return on Liabilities =

[Asset Income + Realized Gains on Assets + Unrealized Gains on Assets] − [Liability Income/Expense + Realized Gains on Liabilities + Unrealized Gains on Liabilities].

[7] The three formulas shown assume no cash inflows or outflows during the period, which is sufficient for our simplified example. However, the formulas can be extended to cover cash inflows and outflows. If, for example, all inflows occur at the beginning of the period and outflows occur at the end of the period, inflows are added to MVA_n and outflows added back to MVA_{n+1} before making the return calculation.

The problem with historical cost accounting is its failure to measure all of the following six components of the change in value of a company's surplus during any given period:

1. Asset Income
2. Realized Gains on Assets
3. Unrealized Gains on Assets
4. Liability Income/Expense
5. Realized Gains on Liabilities
6. Unrealized Gains on Liabilities

Thus, although historical cost accounting might assign proper starting values to the assets and liabilities on its books (assuming historical cost is equal to market or fair value at the time of issue), it will not measure the changes in these values appropriately over time. Although most accounting systems that are currently in use measure the income/expense and realized gains terms for assets and liabilities, the unrealized gains on assets and liabilities are frequently ignored, at least in part.

But unrealized gains and losses represent the change in present value of *future* income. So these gains and losses will be realized in income over time. Thus, the historical cost accounting numbers ultimately will converge to the total return results. However, there is a delay in showing the true performance of the company in this case. So the response to any negative (or positive) developments in the portfolio also may be delayed as a result.

2. SHORT DESCRIPTION OF AN EQUITY-INDEXED ANNUITY AND ITS ECONOMIC RISK

To illustrate more clearly the problems with historical cost accounting and the standards adopted to "correct" it, an example of an equity-indexed annuity (EIA) is used to analyze the issues.

As described in the book *Investment Guarantees* (Hardy 2003), an equity-indexed annuity is a type of insurance product in which the customer pays an initial premium and receives a promised return on their premium that is based on a percentage of the return on an equity index but not less than a guaranteed amount.

For example, the promised return on an EIA may be equal to 60% of the annual return on the

S&P Index but not less than 3% per year on average over the life of the product. The 60% figure is referred to as the customer's participation rate in the S&P Index. The promised minimum return of 3% per year is referred to as a minimum interest guarantee.

It can be shown that this type of EIA has the same risks as a fixed-rate bond and a call option on the S&P Index (see Appendix C).

For example, imagine an equity-indexed annuity with the following features:

Starting premium level: $100,000
Term to maturity: seven years (no early withdrawals permitted)
Guaranteed interest: 3% cumulative interest per year on initial premium
Participation rate: α times the S&P Index, where $\alpha > 0$ and generally $\alpha < 1$.

The risks in this product may be represented precisely by the following components:[8]

1. A seven-year zero-coupon bond with a maturity value of $122,987 and a current market value of $81,793
2. A seven-year call option on the S&P Index with a current market value of $18,207.

(See Appendix C for a detailed explanation of how these components are derived.)

To hedge the risk in this product perfectly, the company that issued the EIA would purchase the following matching assets:

1. A seven-year zero-coupon risk-free bond with a maturity value of $122,987 and a current market value of $81,793
2. A seven-year call option on the S&P Index with a current market value of $18,207.

Alternatively, the company could use the entire $100,000 premium to buy a seven-year zero-coupon bond (with a 6% yield), in which case the risk in the assets and liabilities will not be exactly matched. In this case, the investment portfolio would consist of the following asset only:

1. A seven-year zero-coupon risk-free bond with a maturity value of $150,363 ($100,000 $\times$ 1.06^7) and a current market value of $100,000.[9]

When the assets and liabilities of the company are not matched as in this case, the company will experience fluctuations in the value of its net position as the value of its bond and equity positions change. Therefore, the company is exposed to economic risk.

To illustrate the economic risks associated with this product, assume that there is a change in the interest rate environment immediately following the issue of this product (at time $0 + \varepsilon$, where ε is very small). If, for example, market interest rates fall from 6% to 4%, this will have the following impact on the economic value of the bond components:

1. The market value of a seven-year zero-coupon bond with a maturity value of $122,987 will now be $93,460 ($122,987/1.04^7).
2. The market value of a seven-year zero-coupon bond with a maturity value of $150,363 will now be $114,264 ($150,363/1.04^7).

(See Appendix D for a more detailed explanation of how these new market values were derived.)

For purposes of this analysis, assume that the fall in interest rates also prompts a rally in the equity markets, and the market value of the call option embedded in our product rises from $18,207 to $25,100.

In summary, then, the market values immediately after issue of the product (and after investment of the proceeds) are as follows:[10]

MVA_0 (matched bond) = $81,793
MVA_0 (call option) = $18,207

MVA_0 (unmatched bond) = $100,000

FVL_0 (bond component) = $81,793
FVL_0 (equity component) = $18,207.

[8] This assumes the current rate on a risk-free seven-year security at issue (r_t) is 6%.

[9] The maturity value of the bond in this case is equal to the total amount invested (the initial premium) accumulated at the bond yield at issue over the period to maturity ($P \times (1 + r_t + \theta_t^A)^T$). Since the bond in this case is risk-free, the value of θ_t^A is 0, so this effectively reduces to $P \times (1 + r_t)^T$. Again, r_t is assumed to be 6% at issue.

[10] Throughout the paper, MVA represents market value of assets, FVL is fair value of liabilities, and MVS represents market value of surplus.

However, following the change in market rates and the shift in the equity markets, the new market values are as follows (where ε represents a very small increment of time):

$MVA_{0+\varepsilon}$ (matched bond) = \$93,460
$MVA_{0+\varepsilon}$ (call option) = \$25,100

$MVA_{0+\varepsilon}$ (unmatched bond) = \$114,264

$FVL_{0+\varepsilon}$ (bond component) = \$93,460
$FVL_{0+\varepsilon}$ (equity component) = \$25,100.

Let us now measure the change in the economic value of our portfolio that results from the change in market interest rates and the S&P Index. Since the economic value of the portfolio is based on the fair value of assets, liabilities, and surplus, all measures shown in this analysis are fair value measures. The economic balance sheets before and after the change in market conditions are shown in Figures 1 and 2 for a hedged and an unhedged investment strategy.

As shown in Figure 1, under the fully hedged asset strategy, there is no change in the economic value of the company's surplus due to the change in market interest rates and the S&P Index ($MVS_{0+\varepsilon} - MVS_0 = 0$ even when market conditions change). This is because the change in the value of the company's liabilities is matched exactly by the change in the value of its assets. So there is no net risk in the portfolio in this case.

As shown in Figure 2, there will be a significant negative change in the economic value of the company's surplus resulting from the change in market interest rates and the S&P Index if the company is using the unhedged investment strategy described above.[11] Prior to the change, the value of the company's surplus is \$0, but after the change, its net value has declined by \$4,296. So in this case, there is significant net risk to the value of the portfolio ($MVS_{0+\varepsilon} - MVS_0 \neq 0$ when market conditions change).

3. PROBLEMS WITH RISK MEASUREMENT UNDER THE HISTORICAL COST APPROACH

As noted previously, even though historical cost accounting might assign proper starting values to the assets and liabilities on its books (assuming historical cost is equal to market or fair value at the time of issue), it will not measure the changes in these values appropriately over time.

This section again constructs the balance sheet for the hypothetical asset and liability positions under a hedged and an unhedged investment strategy, but this time using historical cost accounting.

In these illustrations, it is assumed that the cost at issue for the liability is equal to the starting premium allocated to each of its component parts and the cost at issue for the investment portfolio equals the market value of the securities

[11] Since the surplus of the company cannot be negative from an economic standpoint, if these are the company's only assets and liabilities, the company is effectively in default, in which case the value of its surplus would be 0 and the economic value of the liabilities would be reduced to \$114,264 (i.e., the liability holders will not receive the full promised value). This adjustment occurs via an increase in the value of θ_t^L (see Appendix A).

Figure 1

Change in *Economic Value* of the *Hedged* Portfolio

Balance Sheet at Issue ($n = 0$)

Assets (MVA_0):		Liabilities (FVL_0):	
Zero-Coupon Bond	\$81,793	EIA	\$100,000
Call Options on Index	\$18,207		
		Surplus (MVS_0):	
Total Assets	\$100,000	*Net Capital*	*\$0*

Balance Sheet after the Change ($n = 0 + \varepsilon$)

Assets ($MVA_{0+\varepsilon}$):		Liabilities ($FVL_{0+\varepsilon}$):	
Zero-Coupon Bond	\$93,460	EIA	\$118,560
Call Options on Index	\$25,100		
		Surplus ($MVS_{0+\varepsilon}$):	
Total Assets	\$118,560	*Net Capital*	*\$0*

Figure 2

Change in *Economic Value* of the *Unhedged* Portfolio

Balance Sheet at Issue ($n = 0$)

Assets (MVA_0):		Liabilities (FVL_0):	
Zero-Coupon Bond	$100,000	EIA	$100,000
Call Options on Index	$0		
		Surplus (MVS_0):	
Total Assets	$100,000	*Net Capital*	*$0*

Balance Sheet after the Change ($n = 0 + \varepsilon$)

Assets ($MVA_{0+\varepsilon}$):		Liabilities ($FVL_{0+\varepsilon}$):	
Zero-Coupon Bond	$114,264	EIA	$118,560
Call Options on Index	$0		
		Surplus ($MVS_{0+\varepsilon}$):	
Total Assets	$114,264	*Net Capital*	*$(4,296)*

at the time of purchase.[12] This can be represented as follows (where HCA is used for historical cost of assets and HCL is used for historical cost of liabilities):

HCA_0 (matched bond) = $81,793
HCA_0 (call option) = $18,207

HCA_0 (unmatched bond) = $100,000

HCL_0 (bond component) = $81,793
HCL_0 (equity component) = $18,207.

Note that the starting values under historical cost accounting are the same as the market values given our assumptions. After a change in market conditions, however, the values recorded under historical cost accounting will not match those recorded under an economic approach. In general, historical cost accounting values in period $n + \varepsilon$ are calculated as follows:

$HCA_{n+\varepsilon} = HCA_n$ + asset income$_\varepsilon$ + realized asset gains/losses$_\varepsilon$
$HCL_{n+\varepsilon} = HCL_n$ + liability income/expense$_\varepsilon$ + realized liability gains/losses$_\varepsilon$.

When ε is a very small increment of time, there will not be any time for income to accrue or for any transactions to occur that generate realized gains/losses during the period. So the entire effect of a change in market rates or the S&P Index during the period will occur in the form of unrealized gains and losses on the assets and liabilities. But these changes will not impact the balance sheet under historical cost accounting (at least in the short term). So the values of the assets and liabilities after the change in market conditions will be determined as follows:

$HCA_{0+\varepsilon}$ (matched bond) = HCA_0 (matched bond) + 0 + 0 = $81,793
$HCA_{0+\varepsilon}$ (call option) = HCA_0 (call option) + 0 + 0 = $18,207

$HCA_{0+\varepsilon}$ (unmatched bond) = HCA_0 (unmatched bond) + 0 + 0 = $100,000

$HCL_{0+\varepsilon}$ (bond component) = HCL_0 (bond component) + 0 + 0 = $81,793
$HCL_{0+\varepsilon}$ (equity component) = HCL_0 (equity component) + 0 + 0 = $18,207.

The historical cost balance sheets before and after the change in market conditions are shown in Figures 3 and 4 for a hedged and an unhedged investment strategy.

As shown in Figure 3, when the company is using a fully hedged asset strategy, historical cost accounting shows no change in the value of the company's surplus due to the change in market interest rates and the S&P Index. The reported value of surplus before and after the change in market conditions is $0. So the change in the value of surplus due to the change in market conditions is shown correctly in this case ($HCS_{0+\varepsilon} - HCS_0 = MVS_{0+\varepsilon} - MVS_0 = 0$).

Thus, economic risk for a hedged portfolio is reflected properly under the historical cost approach even though the value of the assets, liabilities, and surplus is not based on fair value. But this is only an accident because unreported

[12] In most cases, this assumption is consistent with current GAAP accounting (Crooch and Upton 2001).

Figure 3

Change in Value of the *Hedged* Portfolio under *Historical Cost* Accounting

Balance Sheet at Issue ($n = 0$)

Assets (HCA_0):		Liabilities (HCL_0):	
Zero-Coupon Bond	$81,793	EIA	$100,000
Call Options on Index	$18,207		
		Surplus (HCS_0):	
Total Assets	$100,000	*Net Capital*	*$0*

Balance Sheet after the Change ($n = 0 + \varepsilon$)

Assets ($HCA_{0+\varepsilon}$):		Liabilities ($HCL_{0+\varepsilon}$):	
Zero-Coupon Bond	$81,793	EIA	$100,000
Call Options on Index	$18,207		
		Surplus ($HCS_{0+\varepsilon}$):	
Total Assets	$100,000	*Net Capital*	*$0*

asset gains are offset exactly by unreported liability gains when assets and liabilities are matched.

Furthermore, as shown in Figure 4, the historical cost accounting approach also shows no change in the value of the company's surplus after a change in market conditions when the company uses an unhedged asset strategy. But this is not a correct representation of the company's risk when the portfolio is unhedged, because the economic capital of the company has actually declined substantially, as shown in Figure 2.

In summary, then, the historical cost approach seems to be capable of capturing the risk correctly for a fully hedged portfolio, but it is not capable of capturing risk correctly in the case where the portfolio is not hedged precisely.

4. PROBLEMS WITH RISK MEASUREMENT UNDER SFAS 115

SFAS 115 was one of the first accounting standards adopted to deal with the problems of risk measurement under historical cost accounting. Under the provisions of this standard, liabilities are still measured using a historical cost accounting approach. However, the measurement of a company's assets depends on how the assets in its portfolio are classified (FASB 1993).

Under SFAS 115, assets may be classified in one of the following three categories subject to various qualifications:

1. Assets that will be held to maturity (HTM)
2. Assets available for sale (AFS)
3. Assets that are part of the company's trading portfolio (TR).

Any assets classified in the first category (held to maturity) continue to receive historical cost accounting treatment under SFAS 115. However, assets in the other two categories are marked to market on the balance sheet, although the treatment of gains on the income statement is different depending on whether the assets are ''available for sale'' or classed as ''trading'' assets.[13]

Since the accounting treatment for the assets differs depending on whether they are being ''held to maturity'' or are expected to be sold or traded, the risk that is shown for a portfolio will appear to change depending on the company's trading intentions. But the market risk in a company's portfolio depends on its holdings at a given point in time, not on a company's intentions. So the underlying logic for applying different accounting treatments to each of the investment categories above appears to be flawed.

To illustrate the problems that may result from the application of SFAS 115 to the measurement of the portfolio value, the example of the equity-indexed annuity is used again.

Since the results would be the same as the Section 3 results if the assets were classified as ''held to maturity,'' this possibility will not be considered again. When this is done, the accounting

[13] In the case of ''trading'' assets, any gains and losses flow through the income statement directly, whereas gains and losses on assets that are ''available for sale'' are reported as an adjustment to equity without flowing through the income statement of the company.

Figure 4

Change in Value of the *Unhedged* Portfolio under *Historical Cost* Accounting

Balance Sheet at Issue ($n = 0$)

Assets (HCA_0):		Liabilities (HCL_0):	
Zero-Coupon Bond	$100,000	EIA	$100,000
Call Options on Index	$0		
		Surplus (HCS_0):	
Total Assets	$100,000	*Net Capital*	*$0*

Balance Sheet after the Change ($n = 0 + \varepsilon$)

Assets ($HCA_{0+\varepsilon}$):		Liabilities ($HCL_{0+\varepsilon}$):	
Zero-Coupon Bond	$100,000	EIA	$100,000
Call Options on Index	$0		
		Surplus ($HCS_{0+\varepsilon}$):	
Total Assets	$100,000	*Net Capital*	*$0*

treatment continues to be the same as the historical cost accounting approach.

Instead, one looks at the impact on the company's balance sheet if the assets are classified as ''trading'' assets or assets that are ''available for sale.'' In both of these cases, the balance sheet treatment for the assets should be based on a fair value approach, even though the treatment on the income statement is different. As noted above, however, the liabilities will continue to be measured based on historical cost accounting under an SFAS 115 approach.

Thus, although the values of assets and liabilities on the balance sheet at issue will be the same as under the historical cost approach, the values of the assets and liabilities after the change in market conditions will be as follows under SFAS 115 (using SF115A and SF115L to represent SFAS 115 asset and liability values):

$SF115A_{0+\varepsilon}$ (matched bond) = $MVA_{0+\varepsilon}$ (matched bond) = $93,460
$SF115A_{0+\varepsilon}$ (call option) = $MVA_{0+\varepsilon}$ (call option) = $25,100

$SF115A_{0+\varepsilon}$ (unmatched bond) = $MVA_{0+\varepsilon}$ (unmatched bond) = $114,264

$SF115L_{0+\varepsilon}$ (bond component) = $HCL_{0+\varepsilon}$ (bond component) = $81,793
$SF115L_{0+\varepsilon}$ (equity component) = $HCL_{0+\varepsilon}$ (equity component) = $18,207.

The SFAS 115 balance sheets before and after the change in market conditions are shown in Figures 5 and 6 for a hedged and an unhedged investment strategy.

As shown in Figure 5, a big problem results from measuring only the asset side of the balance sheet using a fair value approach. Although the

Figure 5

Change in Value of the *Hedged* Portfolio under *SFAS 115* (*TR/AFS*)
(Assumes Assets Are Classified as Traded Assets or Assets Available for Sale)

Balance Sheet at Issue ($n = 0$)

Assets ($SF115A_0$):		Liabilities ($SF115L_0$):	
Zero-Coupon Bond	$81,793	EIA	$100,000
Call Options on Index	$18,207		
		Surplus ($SF115S_0$):	
Total Assets	$100,000	*Net Capital*	*$0*

Balance Sheet after the Change ($n = 0 + \varepsilon$)

Assets ($SF115A_{0+\varepsilon}$):		Liabilities ($SF115L_{0+\varepsilon}$):	
Zero-Coupon Bond	$93,460	EIA	$100,000
Call Options on Index	$25,100		
		Surplus ($SF115S_{0+\varepsilon}$):	
Total Assets	$118,560	*Net Capital*	*$18,560*

Figure 6

Change in Value of the *Unhedged* Portfolio under *SFAS 115* (*TR/AFS*)
(Assumes Assets Are Classified as Traded Assets or Assets Available for Sale)

Balance Sheet at Issue ($n = 0$)

Assets ($SF115A_0$):		Liabilities ($SF115L_0$):	
Zero-Coupon Bond	$100,000	EIA	$100,000
Call Options on Index	$0		
		Surplus ($SF115S_0$):	
Total Assets	$100,000	*Net Capital*	*$0*

Balance Sheet after the Change ($n = 0 + \varepsilon$)

Assets ($SF115A_{0+\varepsilon}$):		Liabilities ($SF115L_{0+\varepsilon}$):	
Zero-Coupon Bond	$114,264	EIA	$100,000
Call Options on Index	$0		
		Surplus ($SF115S_{0+\varepsilon}$):	
Total Assets	$114,264	*Net Capital*	*$14,264*

economic value of both the assets and the liabilities of this company has increased as a result of the market changes, only the increase in the asset value is reported under SFAS 115. This creates the false impression that the value of the company's surplus has increased substantially, when in reality the economic value of this company has not changed at all (see Figure 2). Thus, SFAS 115 creates an even bigger distortion in measuring the risk of the company than was present under historical cost accounting. Not only does it indicate risk where none is present, it severely overstates the current value of the company's surplus in this situation.[14]

In the case of the unhedged portfolio also, the SFAS 115 approach overstates the value of the company's surplus in a falling interest rate environment.[15] Although the true economic impact of the change in market conditions actually has been a decline in the value of the company's surplus (see Figure 2), the SFAS 115 approach indicates that the company's surplus value has increased. Thus, not only the value of the change is shown incorrectly, but the direction of the change is incorrect as well.

[14] Note that a rising rate environment would normally have the opposite impact on surplus value since the resulting decline in asset value would be reported but not any resulting decline in liability values.

[15] Note that a rising rate environment would normally have the opposite impact on surplus value since the resulting decline in asset value would be reported but not any resulting declines in liability values.

Although the implications of these results appear to be quite serious in terms of the potential level of distortion reflected in the company's balance sheet under SFAS 115, historical cost measures still are available for the company's entire asset portfolio. Many analysts handle the situation by backing out the fair value of assets and replacing these numbers with the historical cost valuations. Although this leaves us in the same position that we were in under historical cost accounting, it avoids the result of introducing further distortions.

5. PROBLEMS WITH RISK MEASUREMENT UNDER SFAS 133

SFAS 133 recently was adopted with the goal of improving the accounting treatment for derivatives. The general intent of this standard was to account more consistently for derivatives and any positions they might be hedging within the accounting statements.

Under the provisions of SFAS 133, all derivatives on the books of the company (including embedded derivatives in the company's liabilities) are classified according to the type of risk being managed. Effectively, all derivatives are assumed to be associated with one of the following types of risk exposure (FASB 1998, 1999, and 2000; see also Smith 2003):

1. Exposure to changes in fair value of assets and liabilities already on the balance sheet (or firm commitments)

2. Exposure to changes in cash flows on assets and liabilities (or anticipated transactions)
3. Exposure to foreign exchange rates and net investments in foreign operations.

Again, the accounting treatment for these derivatives (and their offsetting balance sheet positions) depends on the category in which they are classified. Thus, this standard (like SFAS 115) assumes that the appropriate measure of risk depends on the type of transaction involved. As pointed out previously, however, the logic behind this assumption is flawed, because the risk of a position should be measured using fair values regardless of the nature of any transactions. So the rationale for setting up these categories does not appear to be justified on the basis of economic considerations.

This paper focuses only on the treatment of derivatives in the first category listed above (i.e., derivatives that are treated as ''fair value hedges'' in the company's accounting statements). Since these are the types of derivatives that are included in our equity-indexed annuity example, a discussion of the treatment for this category will suffice for purposes of this analysis.

In general, SFAS 133 calls for measurement of derivatives in the first category based on the market (or fair) value of the securities themselves. So far, so good. Unfortunately, however, two specific provisions related to these types of derivatives can create significant problems in measurement of the related risk. These provisions are the following:

1. *Separate treatment of the host instrument when derivatives are not ''clearly and closely'' related to their host.*
   SFAS 133 states that when a derivative is not ''clearly and closely'' related to its host instrument, it must be separated (bifurcated) from the rest of the transaction and treated as a stand-alone derivative (see Smith 2003). Although this should not be a problem if the rest of the security was also measured on a fair value basis, this isn't always the case. As a result, one is left with the untenable situation where part of a security may be measured based on fair value while the rest of the same security is measured based on historical cost.
2. *Strict requirements to demonstrate derivatives are a close match for the risks being hedged before they are eligible for ''hedge'' accounting.*
   When ''hedge'' accounting is used, the hedge and the item being hedged both are marked to market. However, under SFAS 133, hedge accounting cannot be used unless a company can demonstrate its derivatives are a close match for the risks being hedged. Effectively, this means the risk cannot be shown properly unless it is low. Although use of fair value measures for a derivative and the position it is hedging would show clearly a large degree of residual risk if the hedge is not a close fit for the risk, the inability to meet the strict requirements for hedge accounting may mean the true risk of the position cannot be shown at all.

To illustrate the problems that may result from the application of SFAS 133 to the measurement of the portfolio value, look again at the example of the equity-indexed annuity. Here, too, it is assumed that our company's assets are classified as ''trading'' assets or assets that are ''available for sale'' under the provisions of SFAS 115. Note that SFAS 133 did not replace SFAS 115, but was instead superimposed over the top of this prior standard. Consequently, the assets in the portfolio will be accounted for on a market value basis under the joint provisions of SFAS 115 and SFAS 133 when they are classified as described above.

In the case of the equity-indexed annuity, however, it will be necessary to bifurcate the embedded option in the product and treat it as a standalone derivative. Effectively, the bond component of the annuity has been deemed the host contract, and the equity component of the annuity has been deemed an option that is not ''clearly and closely'' related to the host contract (see Ernst and Young 2002). Since the host contract itself is not given fair value treatment under the provisions of SFAS 133, this means it will be valued using a different approach from the option that is embedded in the contract. Therefore, in this example, the fixed bond component of the annuity will be valued using a historical cost accounting approach, whereas the equity option component of the annuity will be valued using a fair value approach.

In summary, then, the SFAS 133 values immediately after issue of the product are the same as in the market value and historical cost approach.

However, following the change in market rates and the shift in the equity markets, the SFAS 133 values are as follows (where ε represents a very small increment of time, SF133A is the SFAS 133 asset value, and SF133L is the SFAS 133 liability value):

$SF133A_{0+\varepsilon}$ (matched bond) = $MVA_{0+\varepsilon}$ (matched bond) = $93,460

$SF133A_{0+\varepsilon}$ (call option) = $MVA_{0+\varepsilon}$ (call option) = $25,100

$SF133A_{0+\varepsilon}$ (unmatched bond) = $MVA_{0+\varepsilon}$ (unmatched bond) = $114,264

$SF133L_{0+\varepsilon}$ (bond component) = $HCL_{0+\varepsilon}$ (bond component) = $81,793

$SF133L_{0+\varepsilon}$ (equity component) = $FVL_{0+\varepsilon}$ (equity component) = $25,100.

The balance sheets that result from using this accounting approach are shown in Figures 7 and 8 for the case of the hedged EIA and for the case of the unhedged EIA.

Again there is a problem with the measurement of the net value under the SFAS 133 approach. Although the economic value of both the assets and the liabilities has increased as a result of the market changes, all of the increase in the asset value is reported under SFAS 133, but only part of the increase in the liability value is reported. This again creates the false impression that the value of the company's surplus has increased substantially, when in reality the economic value of this company has not changed at all (see Figure 1). Although this problem is no worse than (and in fact is not as large as) the problem created by SFAS 115 itself, the use of SFAS 133 complicates things further because it is now very difficult to unwind the accounting and return to the results shown under a historical cost approach. This could be done under SFAS 115 by substituting the historical cost of the assets for the market value of the assets and recomputing the net, but it would now be necessary to do this for the embedded liability derivatives as well. But historical cost information on the embedded liability options is not likely to be available any longer. In fact, the net results are now such a mixture of fair value measures and historical cost measures that it's difficult to tell what is going on in the portfolio at all.

In the case of the unhedged portfolio also, the SFAS 133 approach overstates the value of the company's surplus in a falling interest rate environment.[16] Although the true economic impact of the change in market conditions actually has been a decline in the value of the company's surplus in this situation (see Figure 2), the SFAS 133 approach again indicates that the company's surplus value has increased instead.

Thus for the unhedged portfolio shown in this example, the implications of adopting SFAS 133 are quite serious. Not only does the use of this approach overstate the value of our surplus and show an increase in value where a decrease has

[16] Note that a rising rate environment would normally have the opposite impact on surplus value since the resulting decline in asset value would be reported but not any resulting declines in liability values.

Figure 7

Change in Value of the *Hedged* Portfolio under *SFAS 133* (*TR/AFS*)
(Assumes Assets Are Classified as Traded Assets or Assets Available for Sale)

Balance Sheet at Issue ($n = 0$)

Assets ($SF133A_0$):		Liabilities ($SF113L_0$):	
Zero-Coupon Bond	$81,793	EIA	$100,000
Call Options on Index	$18,207		
		Surplus ($SF133S_0$):	
Total Assets	$100,000	*Net Capital*	*$0*

Balance Sheet after the Change ($n = 0 + \varepsilon$)

Assets ($SF133A_{0+\varepsilon}$):		Liabilities ($SF133L_{0+\varepsilon}$):	
Zero-Coupon Bond	$93,460	EIA Bond Component	$81,793
Call Options on Index	$25,100	EIA Equity Component	$25,100
		Surplus ($SF133S_{0+\varepsilon}$):	
Total Assets	$118,560	*Net Capital*	*$11,667*

Figure 8

Change in Value of the *Unhedged* Portfolio under *SFAS 113* (*TR/AFS*)
(Assumes Assets Are Classified as Traded Assets or Assets Available for Sale)

Balance Sheet at Issue ($n = 0$)

Assets ($SF133A_0$):		Liabilities ($SF133L_0$):	
Zero-Coupon Bond	$100,000	EIA	$100,000
Call Options on Index	$0		
		Surplus ($SF133S_0$):	
Total Assets	$100,000	*Net Capital*	*$0*

Balance Sheet after the Change ($n = 0 + \varepsilon$)

Assets ($SF133A_{0+\varepsilon}$):		Liabilities ($SF133L_{0+\varepsilon}$):	
Zero-Coupon Bond	$114,264	EIA Bond Component	$81,793
Call Options on Index	$0	EIA Equity Component	$25,100
		Surplus ($SF133S_{0+\varepsilon}$):	
Total Assets	$114,264	*Net Capital*	*$7,371*

actually occurred, but now it is very difficult to unwind these results and return to a more meaningful measure that will be usable by the investing public.

To be fair in judging SFAS 133, however, it is important to acknowledge that the company might be able to get closer to a correct representation of its risk under this approach by reclassifying its bonds as "held to maturity." If the company does meet the criteria to do this, the value of its assets and liabilities at issue would still be the same, but their value after the change in market conditions would be determined as follows:

$SF133A_{0+\varepsilon}$ (matched bond) = $HCA_{0+\varepsilon}$ (matched bond) = \$81,793

$SF133A_{0+\varepsilon}$ (call option) = $MVA_{0+\varepsilon}$ (call option) = \$25,100

$SF133A_{0+\varepsilon}$ (unmatched bond) = $HCA_{0+\varepsilon}$ (unmatched bond) = \$100,000

$SF133L_{0+\varepsilon}$ (bond component) = $HCL_{0+\varepsilon}$ (bond component) = \$81,793

$SF133L_{0+\varepsilon}$ (equity component) = $FVL_{0+\varepsilon}$ (equity component) = \$25,100.

The balance sheets for a hedged and unhedged EIA using this approach are shown in Figures 9 and 10.

As shown here, the net results for the hedged portfolio match the economic results in this case if the assets are reclassified, and the net results for the unhedged portfolio are much closer to the economic results (though not the same). Therefore, it may be possible to approach a true economic method of accounting for risk under SFAS

Figure 9

Change in Value of the *Hedged* Portfolio under *SFAS 133* (*HTM*)
(Assumes Assets Are Classified as "Held to Maturity")

Balance Sheet at Issue ($n = 0$)

Assets ($SF133A_0$):		Liabilities ($SF133L_0$):	
Zero-Coupon Bond	$81,793	EIA	$100,000
Call Options on Index	$18,207		
		Surplus ($SF133S_0$):	
Total Assets	$100,000	*Net Capital*	*$0*

Balance Sheet after the Change ($n = 0 + \varepsilon$)

Assets ($SF133A_{0+\varepsilon}$):		Liabilities ($SF133L_{0+\varepsilon}$):	
Zero-Coupon Bond	$81,793	EIA Bond Component	$81,793
Call Options on Index	$25,100	EIA Equity Component	$25,100
		Surplus ($SF133S_{0+\varepsilon}$):	
Total Assets	$106,893	*Net Capital*	*$0*

Figure 10

Change in Value of the *Unhedged* Portfolio under *SFAS 113* (*HTM*)
(Assumes Assets Are Classified as "Held to Maturity")

Balance Sheet at Issue ($n = 0$)

Assets (SF133A_0):		Liabilities (SF133L_0):	
Zero-Coupon Bond	$100,000	EIA	$100,000
Call Options on Index	$0		
		Surplus (SF133S_0):	
Total Assets	$100,000	*Net Capital*	*$0*

Balance Sheet after the Change ($n = 0 + \varepsilon$)

Assets (SF133$A_{0+\varepsilon}$):		Liabilities (SF133$L_{0+\varepsilon}$):	
Zero-Coupon Bond	$100,000	EIA Bond Component	$81,793
Call Options on Index	$0	EIA Equity Component	$25,100
		Surplus (SF133$S_{0+\varepsilon}$):	
Total Assets	$100,000	*Net Capital*	*$(6,893)*

133 by judicious reclassification of the company's assets in some instances. However, note that the fixed portions of assets and liabilities still are not shown at their correct market levels, and so this approach is not capable of capturing the risk correctly on any fixed components of the portfolio. Effectively, this is like a return to the historical cost approach on the fixed components, but with fair value accounting for any embedded derivatives. Thus, it will pick up a portion of the risk, but will not pick up risks such as a mismatch between the fixed securities on the asset side and the fixed component of the liabilities, if these are present. If, for example, the company had decided to invest all of its assets in a five-year fixed-rate bond rather than a seven-year fixed-rate bond, this would introduce additional risk into the portfolio that would not be shown by the SFAS 133 approach even with the asset reclassification. Again, it will be very difficult to unwind the results to attempt an adjustment for any of the missing risk.

6. RISK MEASUREMENT UNDER A FULL FAIR VALUE APPROACH

A full fair value accounting approach would account for all of a company's financial assets and liabilities based solely on fair value measures. If such an approach was adopted in lieu of current accounting standards, the results for the EIA product would be the same as those shown in Section 2. In other words, only by reporting the entire asset value and the entire liability value of the portfolio using fair value measures will one ensure that the true economic risk of the portfolio is shown appropriately in each period of the product's life.

7. CONCLUSION

As shown above, the change in net portfolio value from a change in the economic environment will appear to be quite different depending on the accounting approach that is used to measure the change. Table 1 summarizes the change in value that would be shown for a hedged and an unhedged EIA product under different accounting provisions, given a reduction in market interest rates and simultaneous increase in equity markets. These values can be compared to the actual economic change in the value of the product under these conditions (shown in the first column of the table).

As the results in Table 1 indicate, SFAS 115 did not improve on the problems encountered in the historical cost accounting system. Rather, it significantly increased the magnitude of the measurement error that appears under changing conditions. This is also true of SFAS 133 if the assets cannot be classified in a manner that will result in consistent accounting treatment with the liabilities (e.g., if they are classified as trading assets, TR, or "available for sale," AFS, in this case).

SFAS 133 may get closer to the economic results if assets can be classified to give consistent accounting treatment with the liabilities. However, several problems remain with this standard. First, it may not be possible to classify the assets

Table 1
Change in Net Value Shown for an Equity-Indexed Annuity Product and Related Assets

	Economic	Historical Cost SFAS 115 HTM	SFAS 115 TR/AFS	SFAS 133		Full Fair Value
				TR/AFS	HTM	
Hedged	$0	$0	$18,560	$11,667	$0	$0
Unhedged	$(4,296)	$0	$14,264	$7,371	$(6,893)	$(4,296)

in all cases so that consistent accounting treatment can be used for assets and liabilities. Furthermore, even if this were possible, there is no guarantee that the entire risk will be captured properly as long as some assets or some liabilities are not measured using a fair value approach. In addition, the SFAS 133 approach is extremely complex, and it is therefore difficult to unwind the results. This makes it nearly impossible to identify or attempt an adjustment for any missing risk that is not captured under the SFAS 133 approach. And finally, because of the choices in accounting treatment that are available under SFAS 133, there are many possibilities for ''gaming'' the net results.

Because the true economic risks in a portfolio are based on the net fair values of the assets and liabilities, the only accounting approach that will show the true economic risk of a hedged or unhedged portfolio properly is one that uses a full fair value approach to measure all assets and liabilities. Until such an approach is adopted, the risks that are shown by the accounting statements in fact will not be equal to the true economic risks that are being incurred.

Although the economic results ultimately will be realized by the portfolio regardless of the company's trading policy, the realization of these results will be postponed under most current accounting provisions. This occurs whenever the gains and losses on certain assets or liabilities are ignored selectively.

But postponing the recognition of gains and losses may be dangerous if this postpones any response to negative developments in the portfolio as well. After all, how can we expect management to respond to current developments in the portfolio when they are not aware of and/or not rewarded on the basis of these developments at present? Why, for example, would management consider hedging the EIA in our example if it believes that surplus value is increasing by as much as $7,371 in the current period with a portfolio that is not hedged?[17] If, however, the accounting statements showed the reduction in surplus that has actually occurred in the current period $(4,296), then there would be greater incentives to look for and correct the source of this decline.

Adoption of a full fair value system would ensure that the economic results that are being produced by a company's portfolio will be recognized as they materialize, which should enable management to speed up its response time to any negative developments in the portfolio results. This would be a big improvement over the current system of accounting, which potentially can send false signals about the magnitude and direction of the changes in the value of our portfolio.

Other benefits also would derive from adopting a full fair value system. Chief among these would be the reduction in complexity that follows from using one accounting approach for all assets and liabilities. Thus, there would no longer be a need for three different classifications of assets, nor for three different types of hedges, as all assets and all hedges (as well as all liabilities) would be measured on a fair value basis. Not only would this reduce the options for ''gaming'' the net results (by reclassifying various securities), but it also would ensure that all of the risk was being measured on an economic basis at all times.

In conclusion, the true economic risk of the company is derived by measuring all of its assets and all of its liabilities on a fair value basis. So why not adopt a full fair value system and ensure

[17] Although the ''efficient market hypothesis'' argues that analysts will see through the accounting data in estimating the market value of a company's surplus (Ball and Brown 1968), a recent paper notes that ''mounting evidence . . . suggests capital markets might be informationally inefficient and that prices might take years before they fully reflect available information'' (Kothari 2001). This is consistent with a view that delayed recognition of unrealized gains in accounting statements delays their reflection in stock values.

that this risk is reflected in the accounting statements as well?

APPENDIX A

Two approaches for valuing surplus are shown in Section 1. Mathematically, the first approach would be represented as follows:

$$MVA_n = \sum_{t=n+1}^{T} \frac{ACF_t}{(1 + r_t + \theta_t^A)^{t-n}},$$

where

MVA_n = Market value of an asset at time n
ACF_t = Asset cash flows in period t
r_t = Current market rate on a risk-free security maturing at time t
θ_t^A = Spread over the risk-free rate that reflects the risk in the asset being valued
t = Index of time
n = Point in time at which market value is being determined
T = Final maturity of the asset being valued;

$$FVL_n = \sum_{t=n+1}^{T} \frac{LCF_t}{(1 + r_t + \theta_t^L)^{t-n}},$$

where

FVL_n = Fair value of a liability at time n
LCF_t = Liability cash flows in period t
r_t = Current market rate on a risk-free security maturing at time t
θ_t^L = Spread over the risk-free rate that reflects the risk in the liability being valued
t = Index of time
n = Point in time at which market value is being determined
T = Maturity of the liability being valued.

So

$$\begin{aligned} MVS_n &= MVA_n - FVL_n \\ &= \sum_{t=n+1}^{T} \frac{ACF_t}{(1 + r_t + \theta_t^A)^{t-n}} \\ &\quad - \sum_{t=n+1}^{T} \frac{LCF_t}{(1 + r_t + \theta_t^L)^{t-n}}, \end{aligned}$$

where MVS_n = Market value of surplus at time n and the remainder of the terms are defined as above.

It is also possible to represent the second approach mathematically, as shown below:[18]

$$MVS_n = \sum_{t=n+1}^{T} \frac{ACF_t - LCF_t}{(1 + r_t + \theta_t^S)^{t-n}},$$

where

MVS_n = Market value of surplus at time n
ACF_t = Asset cash flows in period t
LCF_t = Liability cash flows in period t
r_t = Current market rate on a risk-free security maturing at time t
θ_t^S = Spread over the risk-free rate that reflects the risk in the equity security being valued (including any risk from leverage)
t = Index of time
n = Point in time at which market value is being determined
T = Maturity (or horizon) of the equity security being valued.

APPENDIX B

In order to ensure that the calculated market value of surplus is equivalent under the method 1 and method 2 approach described in Section 1, all inputs to these methods must be consistent. Effectively, this means that the same values must be used for the following inputs under both methods:

ACF_t = Asset cash flows in period t
LCF_t = Liability cash flows in period t
r_t = Current market rate on a risk-free security maturing at time t
n = Point in time at which market value is being determined
T = Maturity (or horizon) of the security being valued.

In addition, the values used for the risk spreads θ_t^A, θ_t^L, and θ_t^S must reflect the relationship between the risk in the company's assets, liabilities, and surplus appropriately. This means that the risk (and returns) in a company's assets must be equal to the weighted average risk (and returns) reflected in the company's liabilities and surplus. The appropriate relationship is captured by the

[18] For purposes of simplification, taxes are ignored in this analysis.

following equation (Modigliani and Miller 1958, 1963):[19]

$$\mathrm{MVA}_n \times (r_t + \theta_t^A) = \mathrm{FVL}_n \times (r_t + \theta_t^L) + \mathrm{MVS}_n \times (r_t + \theta_t^S),$$

where

MVA_n = Market value of the company's assets at time n
FVL_n = Fair value of the company's liabilities at time n
MVS_n = Market value of the company's surplus at time n
r_t = Current market rate on a risk-free security maturing at time t
θ_t^A = Spread over the risk-free rate that reflects the risk in the asset being valued
θ_t^L = Spread over the risk-free rate that reflects the risk in the liability being valued
θ_t^S = Spread over the risk-free rate that reflects the risk in the equity security being valued.

As surplus value is defined as asset value minus liability value ($\mathrm{MVS}_n = \mathrm{MVA}_n - \mathrm{FVL}_n$), we know that $\mathrm{MVA}_n = \mathrm{FVL}_n + \mathrm{MVS}_n$. Thus, the equation above reduces to

$$\mathrm{MVA}_n \times \theta_t^A = \mathrm{FVL}_n \times \theta_t^L + \mathrm{MVS}_n \times \theta_t^S$$

(subtracting $\mathrm{MVA}_n \times r_t$ from both sides).

Or, dividing both sides by MVA_n, one obtains

$$\theta_t^A = \frac{\mathrm{FVL}_n}{\mathrm{MVA}_n} \times \theta_t^L + \frac{\mathrm{MVS}_n}{\mathrm{MVA}_n} \times \theta_t^S.$$

APPENDIX C

Imagine an equity-indexed annuity with the following features:

Starting premium level: $100,000
Term to maturity: Seven years (no early withdrawals permitted)
Guaranteed interest: 3% cumulative interest per year on initial premium
Participation rate: α times the S&P Index, where $\alpha > 0$ and generally $\alpha < 1$.

The risks in such a product may be precisely represented by the following components:[20]

1. A seven-year zero-coupon bond with a maturity value of $122,987 and a current market value of $81,793
2. A seven-year call option on the S&P Index with a current market value of $18,207.

The bond component in this case represents the present value of the cash flows associated with the minimum guarantee on the liability. Since no early withdrawals are permitted for this product, the cash flows in all periods prior to maturity will be zero, and the cash flow paid at maturity under the minimum guarantee will equal the original premium accumulated at the guaranteed rate over the life of the product. In other words, under the minimum guarantee,

$$\mathrm{LCF}_t = 0 \quad \text{for } t = n + 1 \text{ to } T - 1, \text{ and}$$

$$\mathrm{LCF}_t = P \times (1 + g)^T \quad \text{for } t = T.$$

The present value of this stream of cash flows then is calculated as follows:

$$\mathrm{FVL}_n = \sum_{t=n+1}^{T} \frac{\mathrm{LCF}_t}{(1 + r_t + \theta_t^L)^{t-n}},$$

where

FVL_n = Fair value of a liability at time n
LCF_t = Liability cash flows in period t
r_t = the current market rate on a risk-free security maturing at time t
θ_t^L = Spread over the risk-free rate that reflects the risk in the liability being valued
t = Index of time
n = Point in time at which market value is being determined
T = Maturity of the liability being valued.

Because the product in this case has a minimum guaranteed value equal to the premium cumulating at 3% annual interest for seven years, the fixed component of the product may be rep-

[19] If this condition does not hold, an arbitrage opportunity will be present. For purposes of simplifying the example any tax effects are ignored here (taxes are assumed to be zero). However, the general conclusions of the paper would still hold if the tax effects were included.

[20] As noted by Hardy, the arguments in this Appendix are based on the Black and Scholes concept that two securities with identical payoffs (and risk) must be priced identically or an arbitrage opportunity will exist (Hardy 2003; Black and Scholes 1973).

resented by a risk-free seven-year security maturing at a value equal to $\$100{,}000 \times 1.03^7$. Thus the face value of the fixed component at maturity (LCF_T) will be \$122,987. Assuming that the current market rate on a risk-free seven-year zero-coupon bond is 6%, the present value of this component at the time of issue would be calculated as follows:

$$FVL_0 = \sum_{t=1}^{7} \frac{LCF_t}{(1 + 0.06 + 0)^{t-n}} = 0 + \cdots + 0$$
$$+ 122{,}987/(1.06)^7 = \$81{,}793.$$

Note that this amount is less than the full premium because the guaranteed rate is lower than the current risk-free rate.

Any premium value remaining (\$100,000 − \$81,793 = \$18,207) then can be used to cover the value of the equity option component included in the product. Assuming the product is fairly priced, the participation rate on the product (α) can be set at a level where the amount available to purchase the call options (\$18,207 in this case) will cover exactly the cost of the options needed to pay the excess of the promised equity returns over the minimum guarantee on the product. Thus, for example, if \$30,345 worth of call options would be needed to cover the risk of providing 100% participation in the S&P returns, but only \$18,207 is available, the provider of the product can purchase options that cover 60% (18,207/30,345) of the full risk and set the participation rate at 60%.

To be more precise, the equity risk included in an EIA with a participation rate of α (such as the one above) will be covered by "the payoff (from) a plain vanilla call option, multiplied by $\alpha \times P/S_0$" where

P = Initial premium
S_0 = Starting index value reflected in the call options
α = Participation rate for the EIA product (Hardy 2003).

To cover this risk, "the insurer should buy $\alpha P/S_0$ options on the stock index with (a) term corresponding to the term of the EIA . . . and strike price (determined as follows)" (Hardy 2003):

$$K = S_0/\alpha \times (G/P - (1 - \alpha)),$$

where

K = Strike price reflected in the call options
S_0 = Starting index value reflected in the call options
α = Participation rate for the EIA product
P = Initial premium for the EIA (\$100,000 in this case)
G = Final guarantee value for the EIA (\$100,000 $\times 1.03^7$ in this case).

Because the value of the call options required to cover the equity risk in the product is a function of α, the value available for purchase of options can be matched to the risk in the product by adjusting the value of α to an appropriate level.

APPENDIX D

In the case of a noncallable zero-coupon bond, the cash flows are established at the time the bond is issued and are equal to the following:

$$ACF_t = 0 \quad \text{for } t = n + 1 \text{ to } T - 1, \text{ and}$$
$$ACF_t = P \times (1 + r_t + \theta_t^A)^T \quad \text{for } t = T,$$

where

ACF_t = Asset cash flow in period t
P = Amount invested in the bond at issue
r_t = Current market rate on a risk-free security maturing at time t
θ_t^A = Spread over the risk-free rate that reflects the risk in the zero-coupon bond
T = Maturity of the bond being valued.

Because both the matched bond and the unmatched bond in Section 2 are risk-free securities, the value of θ_t^A is zero, so the asset cash flows established at the time these bonds are issued are determined as follows in this case:

$$ACF_t = 0 \quad \text{for } t = n + 1 \text{ to } T - 1 \text{ and}$$
$$ACF_t = P \times (1 + r_t)^T \quad \text{for } t = T.$$

Thus, the cash flows for the matched bond are equal to the following:

$$ACF_t = 0 \quad \text{for } t = 1 \text{ to } 6 \text{ and}$$
$$ACF_t = \$81{,}793 \times (1 + 0.06)^7$$
$$= \$122{,}987 \quad \text{for } t = 7,$$

and the cash flows for the unmatched bond are equal to the following:

$$ACF_t = 0 \quad \text{for } t = 1 \text{ to } 6 \text{ and}$$

$$ACF_t = \$100{,}000 \times (1 + 0.06)^7$$

$$= \$150{,}363 \quad \text{for } t = 7.$$

The market value for a bond at any subsequent time ($n = 0 + \varepsilon$) then is calculated as follows:

$$MVA_n = \sum_{t=n+1}^{T} \frac{ACF_t}{(1 + r_t + \theta_t^A)^{t-n}},$$

where

ACF_t = Asset cash flows in period t
r_t = Current market rate on a risk-free security maturing at time t
θ_t^A = Spread over the risk-free rate that reflects the risk in the asset being valued
t = Index of time
n = Point in time at which market value is being determined
T = Maturity of the asset being valued.

Again, the bonds included in our example are risk-free, so θ_t^A is zero, and the equation above reduces to the following in this case:

$$MVA_n = \sum_{t=n+1}^{T} \frac{ACF_t}{(1 + r_t)^{t-n}}.$$

Assuming that the market interest rate on a risk-free security changes from 6% at time 0 to 4% at time $0 + \varepsilon$, the new market value for the matched bond at time $0 + \varepsilon$ will be determined as follows (where ε is a very small number):

$$MVA_{0+\varepsilon} = \sum_{t=\varepsilon+1}^{T} \frac{ACF_t}{(1 + r_t)^{t-\varepsilon}} \underset{\varepsilon \to o}{=} 0 + 0 + \cdots + 0$$

$$+ \$122{,}987/(1.04)^7 = \$93{,}460.$$

Likewise, the new market value for the unmatched bond at time $n = 0 + \varepsilon$ will be determined as follows:

$$MVA_{0+\varepsilon} = \sum_{t=\varepsilon+1}^{T} \frac{ACF_t}{(1 + r_t)^{t-\varepsilon}} \underset{\varepsilon \to 0}{=} 0 + 0 + \cdots + 0$$

$$+ \$150{,}363/(1.04)^7 = \$114{,}264.$$

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