Hedging With Derivatives in Tra

By Larry H. Rubin

EMBEDDED DERIVATIVES AREN'T usually the first things pricing actuaries associate with more traditional risk products such as term life insurance, disability insurance, and long-term care insurance. Annuities or universal life, yes. Or maybe some other investment-oriented product. After all, the techniques for pricing risk products have been around for decades and certainly never contained any embedded derivatives.

When I was taking my fellowship exams in the mid-1980s, a popular question was to describe the pricing considerations for just about any insurance product. This question came up so often that a candidate who answered simply, "Interest—a conservative long-term rate should be used," was probably halfway to fellowship.

Most product development at that time consisted of setting a long-term interest rate as low as possible, as much as 600 to 700 basis points below market. If investment earnings exceeded this pricing, the excess was returned to the policyholder in the form of dividends or excess interest credits. The discretionary nature of these credits required the insured to have a high degree of trust in the willingness of the insurance company to pass on excess investment earnings. Fifteen years later we have products that require interest rate guarantees that are closer to market.

A number of products today—particularly long-term care, guaranteed level term, and disability income—don't contain features that allow the passing through of excess interest earnings. This places competitive pressure on actuaries to choose conservative interest rates that aren't *overly* conservative.

What's the difference between a conservative rate and an overly conservative rate? It's not exactly clear. In the early 1990s, the state of New Jersey wouldn't approve a long-term care rate fitting if the loss ratio was computed using rates lower than 7 percent. At the time, this seemed to be a conservative long-term rate. Very few actuaries today would consider 7 percent conservative. By 2010, if rates continue their decline, we may look back at today's conservative rates of 4 percent and 5 percent the same way we look at 7 percent now.

While this article applies to any product that has level premiums and no cash surrender values, the example will focus on long-term care insurance.

Exhibit 1 gives the assumptions and premium rate for a 5 percent per year increasing benefit policy issued at age 65. The key assumption for this analysis is the interest rate assumption—in this case 5½ percent.

The cash flow pattern for this policy is shown in Exhibit 2. For 19 years the policyholder premium, plus investment income, is expected to be greater than what the policyholder receives in benefits. The cumulative amount of this excess forms the "reserve," which is liquidated over the remaining term of the policy as benefit payments exceed the policyholder premium and investment income. This disinvestment policy continues until the policy matures, at which point the asset balance is zero.

Since this product is priced at 5½ percent, the insurance company must be able

EXHIBIT 1
Long-term Care Assumptions

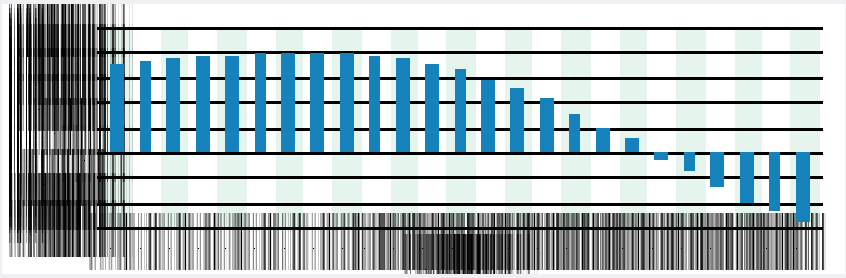
- **ISSUE AGE:** 65
- **PREMIUM:** $2,455 net premium is 70% of gross or $1,718.50
- **INCIDENCE RATES:** 70% of SOA LTC Ins Val Methods Task Force Table (Male)
- **PRICING INTEREST RATE:** 5.5%
- 7-Year Benefit Period
- Benefits are 100 per day in home care or nursing home increasing 5% per year
- Home care benefits are received 4 days per week
- Benefits incurred due to loss of 2 ADLs or cognitive impairment
- Select Factors (20-Year Select Period Linear)

Year 1	5.00%
Year 2	10.00
Year 3	15.00
Year 4	20.00
Year 5	25.00
Year 6	30.00
Year 7	35.00
Year 8	40.00
Year 9	45.00
Year 10	50.00
Year 11	55.00
Year 12	60.00
Year 13	65.00
Year 14	70.00
Year 15	75.00
Year 16	80.00
Year 17	85.00
Year 18	90.00
Year 19	95.00
Year 20	100.00

- **ELIMINATION PERIOD:** 90 Days
- **LAPSE RATES:** 2.00%
- **MORTALITY:** Annuity 2000
- Assume claims incurred end of year

ditional Insurance Products

EXHIBIT 2 Cash Flow—Long-Term Care



There's more than one way to skin a cat, and today's actuaries are discovering there's more than one way to price an insurance policy.

to invest these positive cash flows in assets that earn at least 5½ percent in order to mature its obligation.

To view this through a capital markets lens, when the policyholder pays his premium, he's purchasing a bond yielding 5½ percent. The insurance company is agreeing today, at point of issue, to sell to the policyholder a series of bonds yielding 5½ percent. What the insurance company has done is embed a series of call options in this product.

Granted, the policyholder isn't going to decide to exercise or not exercise his call option based on current market conditions, but rather on whether he feels he needs the coverage. From the insurer's perspective, the reason the policyholder exercises his options is immaterial. What is material is that the policyholder has the options and that there are times when these options may be exercised to the disadvantage of the insurer.

Alternative Interest Rate Scenarios

Exhibit 3 shows the asset buildup for this long-term care policy under various interest rate scenarios. The green line assumes all cash buildup is invested at 5½ percent. We can view this line as the policy reserve without any statutory conservatism or any GAAP provisions for adverse deviations. As long as our assets are above this line, the insurance company can mature its obligation. If asset growth is below this line, the policy will suffer losses.

The blue line in Exhibit 3 compares the asset buildup at 5½ percent and 7 percent. The 7 percent line represents the asset share the product development actuary probably first showed management when developing the business case for first entering the long-term care market. The difference between the green line and the red line represents the excess profits the insurance company would make if rates were to remain unchanged. Actuaries typically would label the 7 percent line the best-guess or expected scenario and the 5½ percent line as a pessimistic scenario.

What's missing from our asset share analysis is the cost of the call options we're selling to the policyholder. If a company were to purchase a series of nine call options on August 2, 2001, and if when the option is exercised the company would receive 5½ percent for 10 years, the com-

EXHIBIT 3
Asset Growth Under Alternative Interest Rates

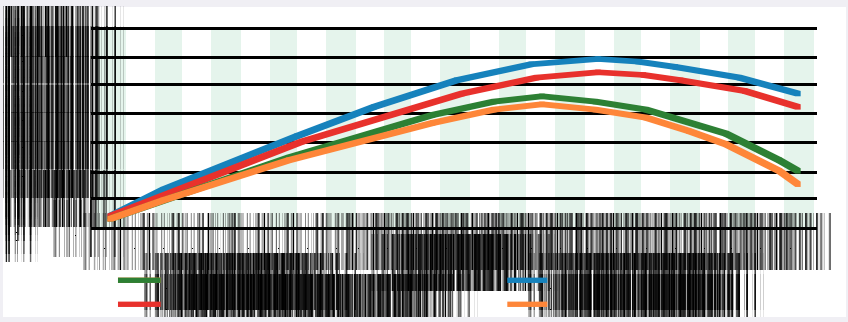


EXHIBIT 4
Buy a LIBOR Floater in Year 3

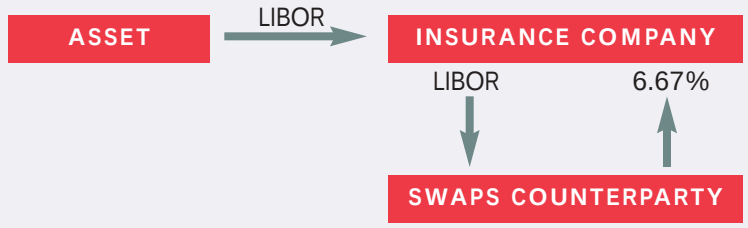
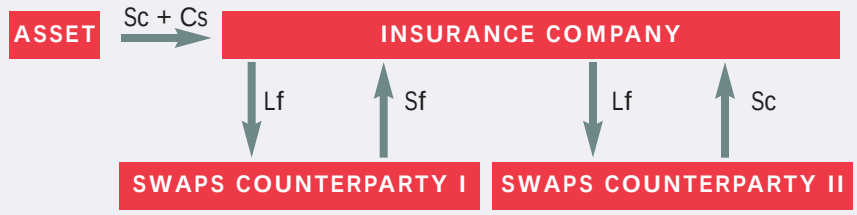


EXHIBIT 5
Offsetting Derivatives



Lf = LIBOR Floating Sf = Swap Forward Sc = Swap Current Cs = Credit Spread over Swaps Fixed

pany would pay $489. When the option cost is reflected in the asset share calculation, the expected profitability falls, as shown by the green line in Exhibit 3. This better reflects expected results.

More critical to the analysis is what happens to our asset share if the policyholder exercises his options to the detriment of the company. The red line in Exhibit 3 shows asset growth if the risk goes unhedged and the market rates are 50 basis points lower than those assumed in pricing. The company has not only lost its expected windfall but has also lost surplus over the life of the policy.

The main point of this analysis is fairly intuitive—an insurance company has a risk on guaranteed level products. If all other assumptions are realized, the company will incur a loss if investment earnings are lower than the level assumed in pricing. The major benefit to recognizing that this risk is an embedded derivative is that it leads us to finding capital market solutions that can eliminate this risk.

There are five strategies that companies have investigated to manage these embedded calls, particularly as they relate to long-term care insurance:

STRATEGY 1

Assume the company will file for a rate increase. An actuary adopting this strategy should ask himself the following questions:

If I recommended a rate increase today because rates are approaching the pricing level, could I get my management to accept the recommendation? Or will the management response be to wait until rates eventually rise?

Do I believe I'll know when rates have gone below the pricing level and will stay there? How long will rates need to be below pricing before action is taken?

Do I know of a company that has filed for a rate increase on the business it wrote 10 years ago because current market rates are lower than the 7 percent to 7½ percent assumed in pricing?

If I could correctly decipher the point where interest rates fell below pricing and stayed there, and if I could convince my management of such, do I believe regulators would grant a rate increase in a timely manner (particularly given that the only reason a rate increase is being requested is my company's failure to hedge the risk)?

Any actuary who answers these questions honestly would probably conclude that this strategy isn't viable. Surprisingly, it's the strategy most often in place and the reason most often given why actuaries don't set up additional reserves when long-term care fails cash flow testing.

STRATEGY 2

Assume the risks offset. A company that has a deferred annuity line would lower its crediting rate as interest rates decline. This large gain would offset its long-term care risk, so long as the portfolio is duration-matched in the aggregate. Very often this benefit is asserted even though the value of the offset isn't tested.

Duration-match is a good strategy for dealing with the risk of interest rate fluctuation. Any year the company loses value due to a decline in interest rates for its long-term care block would be offset by a gain. If the assets and liabilities were shown at market, this would be clearer in the reported results.

A strategy for dealing with fluctuating interest rates, however, isn't the same as a strategy that manages the risk of a general decline in interest rates. Ultimately, if rates decline over the next decade, the annuity portfolio will roll over into lower-yielding assets. So while the extraordinary losses continue on long-term care, the extraordinary gains on the annuity line disappear.

Having described the more popular strategies, here are some of the newer, more effective strategies:

STRATEGY 3

Enter into offsetting derivatives. A call option is equivalent of a series of future starting interest rate swaps. We can close out this position by entering into a series of offsetting forward starting interest rate swaps. Let's look at an example:

If the company has $100 million in long-term care premium coming due in 3 years, it could enter a 3-year forward starting swap with a notional amount of $100 million. The company would make this arrangement with a swap counterparty.

Under this arrangement, beginning in year 3 the company would receive a fixed coupon on the $100 million notional amount and pay the London interbank offered rate (LIBOR). If this fixed coupon is greater than LIBOR, the company would receive a payment from the swap counterparty. This payment would equal the forward starting swap rate, less LI-

BOR. While the forward starting swap rate would remain fixed for the life of the swap, LIBOR would change. Typically, these changes would occur quarterly; in any given quarter the company will either pay or receive cash from the swap counterparty.

In mid-August of this year, a forward starting swap beginning in 3 years and lasting 7 years would have had a fixed coupon of 6.67 percent. In our example, if a company entered into this swap agreement beginning in 3 years, and every quarter thereafter for 7 years, the company would receive from the swap counterparty $100 million x (.0667/4—LIBOR/4). If this amount is negative, the company would pay the absolute value to the swap counterparty.

In 3 years, the company receives its $100 million. At this point the company has two options. The simplest is to buy a floating-rate asset-paying LIBOR. This is illustrated in Exhibit 4. The insurance company is receiving LIBOR from the asset and paying LIBOR to the swap counterparty. These items cancel, and the company is left receiving the swap forward rate—6.67 percent in this example.

The only drawback to this strategy is that companies typically invest in order to receive a spread over swap rates, and the supply of floating-rate assets offering a significant spread is modest.

Another option for the company is to enter into an offsetting swap and buy a fixed-rate credit instrument. Exhibit 5 illustrates this transaction. Under this option, when the cash comes in, the insurance company enters into a 7-year swap in which it pays a fixed rate and receives LIBOR. The cash is used to purchase a fixed-rate asset. The company now has a fixed-rate asset and two interest rate swaps on its books. The flows from this transaction are as follows:

1 Company receives from swap counterparty B LIBOR and pays this to swap counterparty A.

2 Company receives swap forward (SF) from swap counterparty A and pays swap current (SC) to swap counterparty B. So net the company receives SF-SC.

EXHIBIT 6
Total Cash Flow and Premium Long-Term Care Cash Flow (First 10 Years)

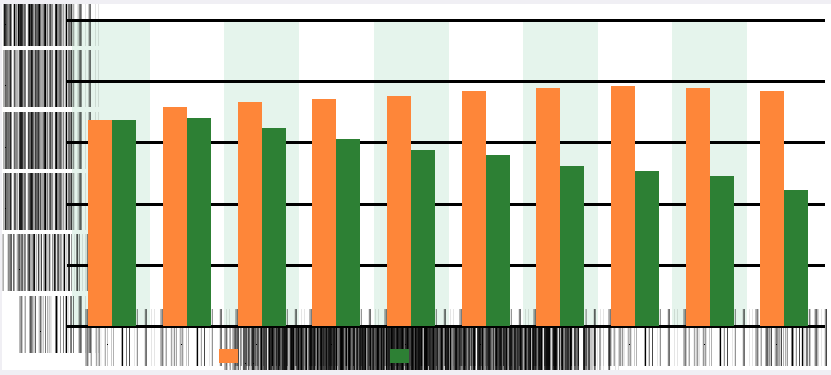


EXHIBIT 7
Structured Liability

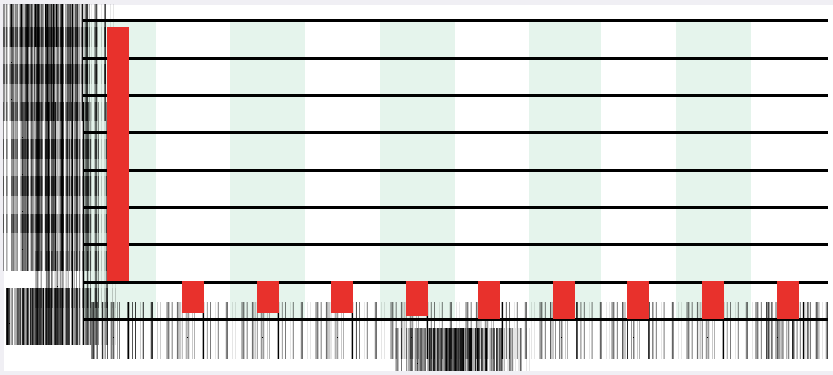
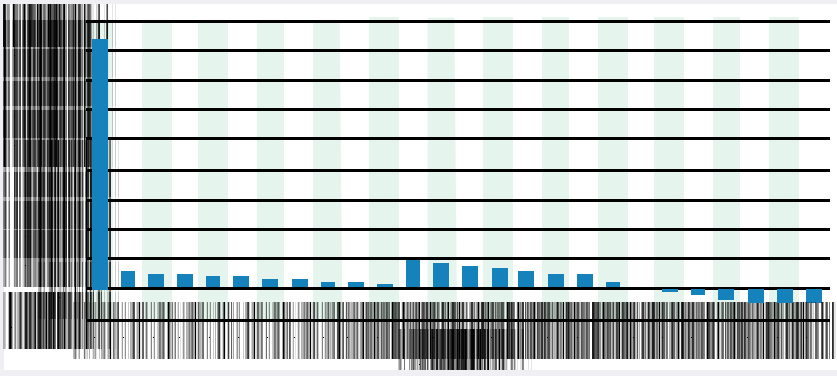


EXHIBIT 8
Structured Liability



3 Company receives from the asset it purchased SC plus the credit spread (CS). So net the company receives SC + CS.

4 In total, the company is receiving SF-SC+SC+CS, which nets to SF + CS.

In our example the insurance company would earn 6.67 percent plus the credit spread then available in the market. If all other assumptions are realized, that there is no counterparty default, and that spreads over swaps don't decline, this strategy should give us a high degree of

confidence that our asset share results are realized.

While this strategy presents an easy to implement hedge of this risk, a number of companies have raised some concerns. One concern is the large counterparty risk exposure. Counterparty exposure is a variant of credit risk. If we look at Exhibit 5, the diagram of this transaction shows where the company is taking counterparty/credit risk. This risk exists when they first enter the forward starting swap agreement, when they enter the offsetting swap, and when they buy the credit instrument. The company now has three times the credit exposure than if it just bought the credit instrument. However, given that swap counterparties tend to be highly rated, the credit risk is probably less than three times.

A more critical concern is the inability to lock in today's credit spreads. When actuaries determine the interest rate assumption for pricing a product, they typically look at the portfolio yield they expect to be available after any expected capital losses. This yield consists of the swap rate plus the credit spread. A company that hedged their interest rate exposure using this strategy could still experience losses is credit spreads declined.

To gain a better appreciation of this risk, we can look at historical credit spreads. The historical difference in yield between Bloomberg's A2 average and 10-year swap rates going back to 1991 is 29 basis points with a standard deviation of 15 BPS. On October 8 of this year, the spread was 90 BPS. Therefore, an actuary pricing by looking at the rates available in today's market, and hedging the risk using forward starting swaps, could miss his pricing target by 60 basis points if credit spreads reverted to their historical norm. This 60-basis-point decline is greater than the 50-basis-point decline assumed in exhibit 3.

STRATEGY 4

Securitizing the premium flow. Exhibit 6 shows the expected cash inflow for our long-term care policy during the first 10 years. The green bar represents the premium portion of this cash flow. These amounts are packaged and sold to the capital markets. This allows the insurance company to receive the bulk of the cash up-front, where it can be invested at today's rates.

Securitization has some significant benefits, including increased earnings, reduced interest rate risk, and increased assets under management. Unfortunately, it also has a number of adverse consequences. The most serious of these occurs in the event of a deviation in lapses/mortality.

Level-premium, no-cash-value insurance policies are lapse supported. When a policy lapses, its reserve is released to the company. The company relies on a certain number of these lapses when pricing its policies.

When lapses are lower than expected, the company needs to set up a higher amount of aggregate reserves. If, in addition, the company has sold off the cash flow, it's exacerbated the problem.

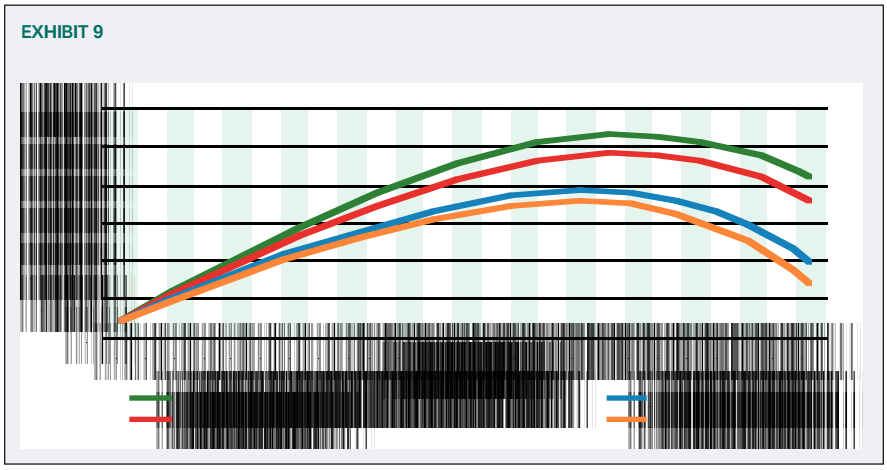
STRATEGY 5

Sell a structured liability. The structured liability strategy is a new strategy that combines the principles and advantages of forward starting swaps and securitization. In this strategy, the insurance company constructs a liability where cash flows are a mirror image of the long-term care cash flows. In implementing this strategy, an insurance company would sell into the capital markets a liability that looks like Exhibit 7. Each of these bars is a mirror image of our long-term care cash flow.

The combined cash flow of these two liabilities is shown in Exhibit 8. The entire cash flow is received up-front, where it can be invested at today's rates. For the next 10 years cash flows are matched, eliminating the risk of changes in rates and/or credit spreads.

More important, since the structured liability itself has a profit margin, we're able to move above the assets-share line to the new level of asset growth shown in Exhibit 9. Assuming all noninterest rate assumptions are realized, the asset growth for the product line will vary minimally due to interest rate fluctuations.

EXHIBIT 9



Advantages of Structured Liability

1 Reduces risk of declining rates for non-putable liabilities;
2 Creates a liability that's inherently profitable. In fact, a company executing this strategy in September would have earned more than a 60 percent before-tax return on capital;
3 Takes advantage of positive slope of yield curve to increase earnings by as much as two times;
4 Increases assets under management;
5 Minimizes use of derivatives and therefore minimizes FAS 133 implications.

For years, insurance companies have used the capital markets to structure assets that meet their cash flow needs. We're now seeing insurance companies using capital markets to structure liabilities that meet their needs. This trend is creating exciting new opportunities and challenges for actuaries. ●

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