INVESTMENT SECTION

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RISKS AND REWARDS

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BY THE SOCIETY OF ACTUARIES

Hedging European Call Option on a Non-dividend Paying Stock in a Random Interest Rate Environment using Futures

by Daniel Hui

Steve Stone explained in the August 2007 issue of Risks and Rewards that a short European call option on a non-dividend paying stock can be hedged by a long stock position and a borrowing in money market account if the interest rate is fixed. However, real markets do not have a single fixed interest rate. On the other hand, some companies implemented hedging using futures instead of stock because futures are more liquid and less costly. This is true on both counts. Does Black-Scholes formula provide any insights on how to hedge an option using futures in the stochastic interest rate environment? Can we just calculate the option delta and purchase futures accordingly?

Metalgesellschaft (MG), a large German trading company, hedged one long forward contract on heating oil with one short futures contract. They sold oil contracts with delivery commitments extending over 10 years. For the delivery commitments of each barrel of oil, they bought one barrel of a short duration futures contracts. This may seem to be a perfect hedge of the delivery commitments on a pure accounting

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SOCIETY OF ACTUARIES

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Taking Stock: Looking into the Rearview Mirror

by Nino Boezio

The year of 2007 was another illustration of how investors need to cope with peaks and valleys in the market. Stock markets worldwide were making new highs entering the summer under a backdrop of stable interest rates, and the prospect of weak U.S. economic growth.

Then, interest rate fears surfaced, starting overseas (in Australasia), which slaughtered the global bond market, and scared the equity markets. The prospect of a U.S. slowdown also virtually disappeared as a theme, and the prospect of higher interest rates surfaced instead for this part of the world. Then the U.S. sub-prime mortgage crisis appeared, not really frightening the world financial markets initially. Also at that time, statistics in the United States suggested that the economy was neither too hot nor too cold, helping the bond market to later recover, albeit modestly.

Then the sub-prime issue became big news. It was a more significant issue than most had expected, and smashing what was once considered to be healthy equity markets around the world. No one truly knew how exposed many financial institutions were to this loss factor, and many could not understand the extent of the liquidity crisis that then ensued as many institutions could not value their portfolios. Fear and panic in a number of sectors then arose and lenders became wary. The United States, in particular, looked like it was heading for an economic mess.

Then the fall season came around, and several statistics suggested that the United States was not in such sad shape as was once thought, due to the sub-prime crisis. Also the U.S. Fed stepped in to help in both lending and in lowering interest rates. Foreign central banks around the world also stepped in to provide added liquidity. The U.S. equity market thus made new all-time highs, only to give it all back and go into negative territory for the year, only to come back up again.

Sometimes the news was all the same, only the reaction differed from day-to-day.

Basically this year has been one of ups and downs (volatility), but it re-emphasized a number of lessons once again for investors.

Trouble Also Spells Opportunity

When problems arise in financial markets, it is important to get out early if one can identify the risk with certainty. Trends continue for a long time, and market runs can go for a much longer period than expected. However, fear and greed, which become exaggerated in times of trouble, create very valuable opportunities. It is important to always have cash on the sidelines to take advantage of opportunities, and to be able to raise cash quickly if danger appears on the horizon. A buy and hold approach is often not the best approach.

Investors have got to Stop Trying to Pick Market Tops and Bottoms

From my personal observation, investors still have not learned to stop picking tops and bottoms. When one misses getting out at a top or getting in at a bottom, they punish themselves and try very hard to convince themselves that it is not a real turnaround, and also to make excuses. Being able to make these market calls are pointless. It is best to take action, and either take some money off the table from time to time, or to take some risk. Rewards ultimately follow when one invests this way, rather than expecting to have superior market timing. It is often the best approach to have your money active, not idly sitting in a set investment for a protracted period of time.

When any market is either rising or declining, some try to guess when that market is poised for a turnaround. Your best bet is to forget trying to do that. However, it does not hurt to pare back or add to a market position as a trend continues. Rebalancing one's portfolio is an important element to any investment plan, and one should not expect to ride the winners and avoid the losers forever. We should remember that sectors such as those pertaining to resources were a bad bet going back more than five years ago.

I have noted clients who have dropped into or out of a market, and they did preserve their capital and saved some of their prior accumulated gains, or otherwise mitigated some of their losses (their market timing move did help). But ironically, they then became totally confused (if not paralyzed) as to when to get back in or back out. They never made a decision on what to do next. Ironically, some who bailed out of various investments during the subprime crisis, saved themselves a loss in their portfolio of more than 2- to 4-percent, but then in the end lost as much as 2- to 4-percent in the ensuing rally, because they could not figure when to get back in, and got back into the market at prices which were higher than when they first bailed out. This is a sad epitaph (but one that repeats itself often) for those who may have a keen sense of danger, but yet do not have a keen sense for risk appetite or when the market is experiencing relief.

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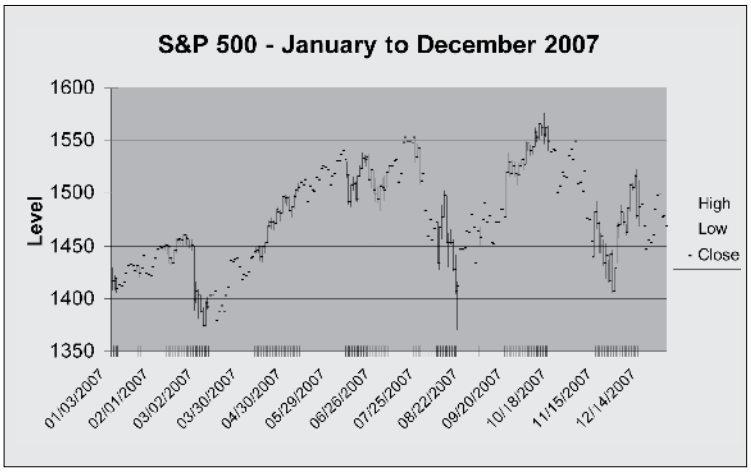
The Best Approach is to Dip Your Toe In or Out—At Least Gradually

When crises arise, or when markets are pricing in very good times, these are situations where some form of portfolio rebalancing needs to take place. Buying and holding is not usually the best approach, as markets do change (many of the top 50 Dow Stocks of the 1970s, as cited in some studies, are not around anymore). If you get in or get out too early you should not fret, for one way to avoid regret is to still have a position, and not allocate the entire amount of assets to that asset class. However, being in that situation will cause you to monitor the position realistically, and then avoid the panic of being fully committed or fully uncommitted to that asset class, which is often not an attractive situation to be in, in either case.



The Perception of Hedge Funds

Hedge funds have been considered a welcome addition to the wide complement of investment

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When crises arise, or when markets are pricing in very good times, these are situations where some form of portfolio rebalancing needs to take place.

vehicles available in the market. However, we are now also learning the limitations of hedge funds in an investment portfolio. Their lack of liquidity and irregular valuation even in the best of circumstances, have posed a problem for certain investors. This problem was certainly exaggerated this summer. Ironically, even when a hedge fund made a good call by being "short" sub-prime exposure, they were still limited in their ability to value their gains. Problems like this created issues with respect to how existing unit holders would be rewarded, and also limited the ability of new unit holders to buy the funds. Many of the problems that have existed with sub-prime certainly have an actuarial flavor to them, in that contingencies such as overall exposure, default risk, and other factors, resemble decrements and risks that actuaries have valued in all sorts of products for years, and could spell another opportunity for the profession to become involved.

Conclusion

Crises come and go, and so do opportunities. We cannot expect to have smooth sailing all the time. On the other hand, it is always useful to devote part of a portfolio to risk capital (for when those disasters do develop, creating opportunities) while it is also valuable to take some money off the table from time to time, from a strongly performing asset class. Being able to shift between asset classes and having the liquid capital to do so can provide ample opportunities. Even though arguments are sometimes made that allocations made to cash and equivalent investments can produce a performance drag on a portfolio (which is true) considerations always need to be made as to when a trend (either positive or negative) has run its course and thus requires money to be shifted elsewhere.

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perspective. Unfortunately, as the market moved against MG in 1993, they had to engineer a 2.2 billion dollar rescue. The company was in intensive care for a long time. What went wrong there? We will have more on this later.

In this article, I would like to lay out a generic framework on how to hedge a European call option on a non-dividend paying stock using futures in a stochastic interest rate environment. In doing this kind of analysis, stochastic calculus is unavoidable. Formulas (1) - (3) and (6) are used in the derivation. If you accept these formulas, you can carry out and understand the following analysis.

Ito-Doeblin Formula

Stochastic calculus is built on probability theory and Lebesgue integral. Interested readers can refer to the book "Stochastic Calculus for Finance II Continuous-time Model" by Steve Shreve. Here we accept the Ito-Doeblin formula without deriving it. W. Doeblin, a French soldier, derived a similar formula to Ito's in the Second World War and he died shortly after. The document he submitted was not discovered until recently. Some authors now refer to the formula as Ito-Doeblin formula.

We will use lower case letter for real variable. We will use upper case letter for stochastic variable that depends on a drift term and a stochastic or random term $\omega(t)$. For brevity of exposition, I will drop $\omega(t)$ from the stochastic variable, but its presence is understood.

The following are the Ito-Doeblin formulas and the Ito product rule. We will use these formulas several times in this analysis. We assume there is a function f(t, X(t)) which depends on the real variable t and the stochastic variable X(t). f_x denotes the partial derivatives of the function f with respect to X(t).

One-dimensional

$$df(t,X(t)) = f_t(t,X(t))dt + f_x(t,X(t))dX(t) + \tfrac{1}{2} f_{xx}(t,X(t))dX(t)dX(t) \quad (1)$$

Two-dimensional in compact notation

$$df(t,X,Y) = f_t dt + f_x dX + f_y dY + \tfrac{1}{2} f_{xx} dX\ dX + f_{xy} dX\ dY + \tfrac{1}{2} f_{yy} dY\ dY \quad (2)$$

Ito product rule

$$d(X(t),Y(t)) = X(t)dY(t) + Y(t)dX(t) + dX(t)dY(t) \quad (3)$$

Stochastic variable differs from real variable in that the quadratic variation for stochastic variable is not zero. If X(t) is a real variable, the last term in equation (1) will disappear.

Martingale is a concept that the current state, based on the available information is our best guess of a stochastic quantity in the future. There is no up or down trend. Martingale is defined as follows.

Definition of martingale:

$$M(s) = \tilde{E}[M(t) \mid \Im(s)] \text{ for } 0 < s < t < T \text{ and } M(t)$$

is an adapted stochastic process and $\Im(s)$ is the information set available at time s. $\tilde{E}$ is the risk-neutral expectation under $\tilde{P}$ probability.

It can be shown that if a stochastic variable, say X(t), is a martingale, the coefficient of the dt term in dX(t) is zero. We will apply this concept again and again in the following analysis.

A Model of the Economy

Before we proceed, we build the model of the economy and the available assets in the economy. It will be shown later that our primary hedging assets are futures and zero coupon bond. We need a model for both.

Interest Rate

The interest rate is assumed to be random and follow a generic short rate model in the risk-neutral (RN) world. Depending on the selection of the function $\beta(t,R(t))$ and $\gamma(t,R(t))$, this will become either the Ho-Lee, the Hull-White model or any other short rate model.

$$dR(t) = \beta(t,R(t))dt + \gamma(t,R(t))d\tilde{\omega}_1(t) \quad (4)$$

Stock

The stock is assumed to follow the geometric Brownian motion in the RN world:

$$dS(t) = R(t)S(t)dt + \sigma(t)S(t)d\tilde{\omega}_2(t) \quad (5)$$

and the stock and interest rate processes are assumed to be correlated:

$$d\tilde{\omega}_1\, d\tilde{\omega}_2 = \rho dt; d\tilde{\omega}_1 d\tilde{\omega}_1 = d\tilde{\omega}_2 d\tilde{\omega}_2 = dt;\ dt\, dt = d\tilde{\omega}_1 dt = d\tilde{\omega}_2 dt = 0 \quad (6)$$

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Where $d\tilde{\omega}_1$ *and* $d\tilde{\omega}_2$ are Brownian motions under $\tilde{P}$ probability in the risk-neutral world.

Therefore

$$dR\,dR = \gamma^2(t,R(t))dt \quad \text{and} \quad dS\,dS = \sigma^2 S^2(t)dt$$

Discount Process

Discount process is:

$$D(t) = e^{-\int_0^t R(u)\,du}$$

Let $I(t) = \int_0^t R(u)\,du$ and dI(t)=R(t)dt.

We apply the one-dimensional Ito-Doeblin formula to get $dD(t) = df(I(t)) = f'(I(t))dI(t) + \frac{1}{2}f''(I(t))dI(t)dI(t)$, which is equivalent to

$$dD(t) = -R(t)\cdot D(t)\cdot dt \tag{7}$$

Zero Coupon Bond

The price of a zero coupon bond at time t that pays $1 at time T is B(t,T). This is a function of time t and interest rate R(t). Therefore, B(t,T) is the discount present value at time t of $1 pay at time T.

$$f(t,R(t)) = B(t,T) = \tfrac{1}{D(t)}\tilde{\mathrm{E}}[D(T)\cdot 1 \mid \Im(t)]$$

where $\Im(t)$ is the information set available at time t.

D(t) B(t,T) is a martingale in the RN world. This means that the trend is flat. To see this, we apply iterative expectation:

$$D(s)B(s,T) = \tilde{\mathrm{E}}[\tilde{\mathrm{E}}[D(T)\mid\Im(t)]\mid\Im(s)] = \tilde{\mathrm{E}}[D(T)\mid\Im(s)]$$

Since we cannot look ahead, what we know at time s is the information we have. What we may find out at later time t is irrelevant at this point. This implies that the drift term or dt term in d(D(t) B(t)) must be zero. Only the stochastic term remains.

$$\begin{aligned} d(D(t)B(t,T)) &= B(t,T)dD(t) + D(t)dB(t,T) + dD(t)dB(t,T)\\ &= -R(t)D(t)B(t,T)dt + D(t)(f_t dt + f_R dR(t) + \tfrac{1}{2}f_{RR}dR(t)\,dR(t))\\ &= D(t)(-Rf + f_t + \beta f_R + \tfrac{1}{2}\gamma^2 f_{RR})dt + D(t)\gamma f_R d\tilde{\omega}_1\\ &= D(t)\gamma(t,R(t))\,f_R(T,R(t))d\tilde{\omega}_1(t) \end{aligned}$$

Because the dt term must be zero, we have:

$$R(t)f(t,R(t)) = f_t + \beta f_R + \tfrac{1}{2}\gamma^2 f_{RR}$$

We substitute this in the derivation for dB(t,R(t)) to get:

$$\begin{aligned} dB(t,R(t)) &= f_t dt + f_R dR + \tfrac{1}{2}f_{RR}dRdR\\ &= (f_t + \beta f_R + \tfrac{1}{2}\gamma^2 f_{RR})dt + \gamma f_R d\tilde{\omega}_1\\ &= R(t)f(t,R(t))dt + \gamma(t,R(t))f_R(t,R(t))d\tilde{\omega}_1(t) \end{aligned} \tag{8}$$

Futures

The futures price on a stock at t with maturity at T is the expected price of the stock at time T given the available information at time t. This is a function of time t, interest rate and stock price. The futures price is a function of time t, interest rate R(t) and current stock price S(t).

$$g(t,S(t),R(t)) = Fut_S(t,T) = \tilde{\mathrm{E}}[S(T)\mid\Im(t)]$$

It is easy to see that this is a martingale in the RN world when we apply iterative expectation with 0<u<t<T. We have:

$$Fut_S(u,T) = \tilde{\mathrm{E}}[Fut_S(t,T)\mid\Im(u)] = \tilde{\mathrm{E}}[\tilde{\mathrm{E}}[S(T)\mid\Im(t)]\mid\Im(u)] = \tilde{\mathrm{E}}[S(T)\mid\Im(u)]$$

The futures price itself is a martingale. The dt term in $dFut_S$ is zero and only stochastic terms remain. We apply the two-dimensional Ito-Doeblin formula in calculating $dFut_S$.

$$\begin{aligned} &dFut_S(t,T) =\\ &g_t dt + g_R dR + g_S dS + \tfrac{1}{2}g_{RR}dRdR + \tfrac{1}{2}g_{SS}dSdS + g_{RS}dRdS\\ &= (.....)dt + \gamma g_R d\tilde{\omega}_1 + g_S \sigma S d\tilde{\omega}_2\\ &= \gamma(t,R(t))g_R(t,R(t),S(t))d\tilde{\omega}_1(t) + g_S(t,R(t),S(t))\sigma(t)S(t)d\tilde{\omega}_2(t) \end{aligned} \tag{9}$$

European Call Option

Let c(t,S(t),R(t)) be the price of the European call option on a non-dividend paying stock which pays max(0,S(T)-K) or $(S(T)-K)^+$ at maturity – time T. The call price at time 0 is c(0,S(0),R(0)) and c(T,S(T),R(T))=$(S(T)-K)^+$. Applying the two dimensional Ito-Doeblin formula and omitting the argument (t,S(t),R(t)) in several places, we got:

$$\begin{aligned} &d(D(t)\cdot c(t,S(t),R(t))\\ &= D(t)(c_t + c_s RS + \beta c_R + \tfrac{1}{2}\sigma^2 S^2 c_{SS} + \rho\sigma\gamma S c_{SR} + \tfrac{1}{2}\gamma^2 c_{RR} - Rc)dt\\ &\quad + \gamma D c_R d\tilde{\omega}_1 + D\sigma S c_S d\tilde{\omega}_2\\ &= D(t)\gamma c_R d\tilde{\omega}_1(t) + D(t)\sigma(t)S(t)c_S d\tilde{\omega}_2(t) \end{aligned}$$

The dt term is zero since the discounted option price is a martingale under risk-neutral measure.

Hedging Portfolio

In this model, we require that the option, the zero coupon bond and the futures mature at the same time T. Let X(t) be the capital of the hedging portfolio at time t and X(0) is the capital at time 0. Assuming that c(0,S(0),R(0)) is known, we can set up X(0)=c(0,S(0),R(0)). If we can match the change in discount portfolio value, d(D(t) X(t)), over time with the change in the discounted option price d(D(t) C(t,S(t),R(t)) by holding the appropriate amount of futures and zero coupon bonds, we will have $X(T)=c(T,S(T),R(T))= (S(T)-K)^+$ almost surely. This is because we started with the same position X(0)=C(0,S(0),R(0)) and we match the change in value over time. We will end up with the same position at time T.

The hedging portfolio X(t) consists of $\Delta(t)$ futures, $\Gamma(t)$ zero coupon bond B(t,T) which mature at time T and the balance of the portfolio is either lending or borrowing in the money market. The change in value of the hedging portfolio and hence the change in discounted portfolio value are:

$$dX(t) = \Delta(t)dFut_S(t,S(t)) + \Gamma(t)dB(t,T) + R(t)(X(t) - \Gamma(t)B(t,T))dt \quad (11)$$

$$\begin{aligned} &d(D(t)X(t)) \\ &= -R(t)D(t)X(t)dt + D(t)dX(t) \\ &= -R(t)D(t)X(t)dt + D(t)(\Delta(t)(\gamma g_R d\tilde{\omega}_1 + \sigma S g_S d\tilde{\omega}_2) + \\ &\quad \Gamma(t)(Rfdt + \gamma f_R d\tilde{\omega}_1) + R(X - \Gamma B)dt) \\ &= D(t)(\Delta(t)\gamma g_R + \Gamma(t)\gamma f_R)d\tilde{\omega}_1 + D(t)\Delta(t)\sigma(t)S(t)g_S d\tilde{\omega}_2 \end{aligned}$$

In order to have d(D(t)X(t)=d(D(t)C(t,S(t)), we need to make the following selections.
Futures :

$$\Delta(t)g_S = c_S(t,S(t),R(t)) \quad \Rightarrow \quad \boxed{\Delta(t) = \frac{c_S}{g_S}}$$

and

Zero coupon bond:

$$\Delta(t)g_R + \Gamma(t)f_R = c_R \Rightarrow \quad \boxed{\Gamma(t) = \frac{c_R - \Delta(t)g_R}{f_R}}$$

Black-Scholes equation tells us that when we hedge a European call option with stock and the interest rate is constant, we need to hold CS(t,S(t)) of stock and a money market account.

When the interest rate is random and we are hedging with futures instead of stock, we will need to hold $\Delta(t)$ futures and $\Gamma(t)$ zero coupon bonds as indicated above. In addition to option delta, we need to know the sensitivity of futures price to changes in stock price as well as interest rate in order to calculate the proper hedge.

Tailing the Hedge

Let us assume that the interest rate is constant. Now we have r instead of R(t). The futures is not random any more. The futures is dependent on the interest rate r and the current stock price S(t).

$$\begin{aligned} g(t,S(t)) &= Fut_S(t,T) = \tilde{E}[e^{r(T-t)}S(t) \mid \Im(t)] = e^{r(T-t)}S(t) \\ g_s(t,S(t)) &= Fut_s(t,T) = e^{r(T-t)} \\ \Delta(t) &= \frac{c_s(t,S(t))}{g_s(t,S(t))} = \frac{c_s(t,S(t))}{e^{r(T-t)}} = e^{-r(T-t)}c_s(t,S(t)) \end{aligned}$$

The number of futures contract needed for hedging the call option is the present value of the option delta when the interest rate is fixed. Some authors call this tailing the hedge.

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There were a lot of things that went wrong in MG's case. For one, hedging one forward contract with one futures contract is more than what is needed especially when it is far from maturity. Some estimated that MG needed only about half of the futures contracts to hedge the forward contracts. Stephen Ross did the forensic study for MG. He reckoned that the so-called hedged position was actually riskier than the naked position.

Conclusion

Black-Scholes model shows the hedging of European option using the underlying in a fixed rate environment. This analysis accounts for random interest rate and hedging with futures instead of the underlying. Section 4 shows the hedge ratio using futures in a random interest rate situation and section 5 shows the hedge ratio when the interest rate is assumed to be constant. In each case, the hedge ratio does not equal to the option delta.

This illustrates the pitfall in simply plugging in the arbitrage-free interest rate model, discounting cash flows and calculating the Greeks. There is nothing wrong in doing all these things. The problem is the hedge ratio can be different from the option delta. Without writing down a proper model, it is easy to lose sight of the risk factor that one is hedging against. It would be misguided to rely only on the option Greeks in setting up the hedges. What happened to MG in 1993 was a perfect example. Whoever wants to be the next, please stand up.

Attention Life Insurance Actuaries! Standard & Poor's Needs You (and C-3 Phase II) for its Insurance Capital Model

by Greg Gaskel and Dave Ingram

In its insurance capital model, Standard & Poor's Ratings Services has established criteria to adopt the NAIC's stochastic approach to variable annuity risk. This approach, which replaces existing static charges, better reflects the products' risk.

Surprisingly, although the NAIC requires the stochastic calculations, many insurance companies have struggled to provide us with reliable data. As a result, we have revised our static charges for variable annuities as a new default charge pending analyst verification of the stochastic results which we would prefer to incorporate. (See "Life Insurance Criteria: C-3 Phase II Adoption For Variable Annuity Risks Provides Enhanced Comparability And Consistency For Use," Feb. 16, 2006, and "Static Capital Charges For Variable Annuities With Living And Death Benefits Revised," May 11, 2007. Both of these articles are published on RatingsDirect, Standard & Poor's Web-based credit analysis system, at www.ratingsdirect.com.)

In launching these criteria, we have spoken with numerous constituents, including company actuaries and actuarial consulting firms. Most folks generally agree with Standard & Poor's stochastic approach. So what's gone wrong? In part, we suspect that some insurance company rating contacts coordinating Standard & Poor's annual survey request might not be reaching the right sources (actuaries) for this relatively new request with a cryptic name. Others could be misinterpreting what we are looking for. Lastly, given the complexities and confusion of adopting the NAIC requirement, there are probably companies with results that are erroneous. We believe the last case is a small minority of companies, and the overall enterprise risk management (ERM) practices of those companies would be called into question. We hope to address the first two issues by further clarifying our request and inviting actuaries to proactively assist within their companies or reach out to us for information.

If you've made it this far, you're also probably aware of the background to C-3 Phase II and the requirement to hold capital for the long-term risks of variable annuity riders, such as guaranteed accumulation, income, and withdrawal benefits. Standard & Poor's directly uses required stochastic results, while the NAIC's approach is somewhat convoluted, taking the greater of deterministic and stochastic results and optionally allowing companies to phase-in this result with old static basis. (It seems most of the insurance industry didn't realize the phase-in was optional, and they are now locked in).

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Stochastic Risk Modeling

Stochastic modeling is the preferred method by which Standard & Poor's would like to reflect the living and death benefit risks in its capital model. The NAIC requires companies to rank-order their stochastic results and average the worst 10 percent of the results—referred to as the conditional tail expectation (CTE(90)—as part of its approach. Standard & Poor's uses the same data to determine the CTE(90) with two key differences:

- We need various CTE results, which we correlate to rating-based target capital levels.
- We need the results with and without the benefit of hedging, as we only provide partial credit.

Stochastic modeling is the preferred method by which Standard & Poor's would like to reflect the living and death benefit risks in its capital model.

Standard & Poor's survey requests the total assets required (TAR)——with and without hedging—at various CTEs and the associated statutory reserves. The capital required is based on the difference of the TAR at various CTE levels minus the reserves held, and it allows 50 percent credit for the value of hedging. Our new capital model (see "New Risk-Based Insurance Capital Model," May 23, 2007) calculates minimum capital to be held at various target ratings by stressing risks to various confidence intervals. Similarly, capital needs for variable annuities under the revised model are based on CTE results. As a result, CTE(90), CTE(95), CTE(97), and CTE(99) correlate with BBB, A, AA, and AAA capital requirements, respectively. The current capital model will use the CTE(90) results.

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As a simple example, if an AA rated company's variable annuity capital at CTE(97)was $100 million without hedging and $50 million with hedging, Standard & Poor's would require $75 million to be held in capital. (The calculated result will have a floor risk charge of zero and not allow a capital credit to be generated.) The initial credit associated with hedging programs might be adjusted as Standard & Poor's gains comfort with each insurer's specific hedge programs and broader ERM.

The CTE data should be based on the American Academy of Actuaries' prepackaged scenarios to ensure reasonably comparable results. For hedging credit, companies must use clearly defined hedging strategies. It is understood that insurers will be incorporating statistical compression techniques to reduce the tremendous burden of running 10,000 scenarios. However, insurers modeling fewer than 1,000 stochastic scenarios need to provide Standard & Poor's an explanation to support the robustness of their modeling. The number of indices used in the replication of mutual funds will also be a qualitative consideration. It is also conceivable that Standard & Poor's will allow scenarios other than the prepackaged versions, but for that to happen, a deeper, company-specific review will be required.

Another divergence from regulatory adoption is that an adjustment will be made to reflect that reserves held for variable annuity benefits—in addition to cash surrender values—are not usually available to a company in a stress situation.

Revised Static Risk Charges

As mentioned, we've found getting stochastic company results from our C-3 Phase II survey to be surprisingly challenging. Therefore, Standard & Poor's has revised its static-risk capital charges for variable annuities with living and death benefit riders. Typically the revised static risk charges are more onerous than the stochastic ones.

The static charges apply to U.S. insurance companies where stochastic results cannot reasonably be applied because of either errors or questionable standards (fewer than 1,000 scenarios, etc.). The revised static living and death benefit risk charges are now the default capital charge for living and death benefit risk. However, we will review each insurer's C-3 Phase II survey submission and will replace the new default static risk charges if we consider the stochastic survey results to be reasonable. The new static charges will apply to both the current and revised capital models, which we are running concurrently in 2007 for our evaluation of risk-adjusted capital for year-end 2006.

The revised static capital charges for variable annuities with living and death benefit riders are based on information available through the requirements associated with NAIC C-3 Phase II and related actuarial analysis. Deterministic scenarios have been generated to represent the various at-the-money risks associated with guaranteed minimum benefits such as with associated accumulation, income and withdrawal riders. As with other factors in the revised capital model, the risk charges have been calibrated with confidence intervals associated with target rating levels (AAA, AA, etc.). The factors associated with BBB will be applied under the current model (see table).

We understand that these new static factors will not represent every company's risk given different product designs and varying market conditions. However, Standard & Poor's believes these new estimates reflect typical risks. We will not generally

Revised Static Capital Charges For Variable Annuities With Living And Death Benefit Riders

(%)	AAA	AA	A	BBB
Return of premium death benefits	0.77	0.56	0.42	0.18
Death benefits enhanced*	3.99	3.37	2.85	1.61
Withdrawal benefits	5.52	3.46	2.73	1.37
Accumulation benefits	2.29	1.66	1.24	0.52
Income benefits	2.67	2.11	1.62	0.71
Others	3.05	2.23	1.77	0.88

*Roll-up or ratchet

make company-specific exceptions to these revised static capital charges, as we believe the best way to capture company-specific risk is through the required stochastic modeling that each insurer performs for its liabilities.

Static factors before C-3 Phase II (2005)

The prior factors did not differentiate by various riders but were solely based on riders being in or out of the money. Previous static capital charges for living benefits were a) 1 percent of variable annuity account balances that are out of the money, or b) 2 percent of variable annuity account balances that are in the money. Under the new approach, the degree to which riders are in the money will be reflected in the reserve base as reserving standards evolve (Variable Annuity Commissioner's Annuity Reserve Valuation Method; VA CARVM).

Background on the Development of the Revised Static Charges

The revised static risk charges were developed following a review of a series of more than 150 stress tests. The stress tests were applied to a static model of variable annuity benefits and considered a range of specific product designs, annuitant ages, option exercise levels, mortality levels, and annual withdrawal/surrender levels. For these stress tests, we assumed business to be hedged with a program that was 75 percent effective, meaning that when a loss event occurred, a hedge gain was assumed to offset 75 percent of the loss cost (50 percent for the more complex guaranteed minimum income benefit) of the annuity excess benefit costs. We gave the hedging offset a haircut of 50 percent, which is consistent with criteria for the stochastic-based program. Companies without hedge programs will not receive the hedge offset.

The stress tests were based on the same scenarios that are the basis for the asset-related charges in the revised capital model for equities. Similar scenarios were developed for interest rate and corporate bond fund experience. Policyholder funds were assumed to be invested in a stock/bond mix with no rebalancing.

Clearly, these tests do not accurately represent any specific company's book of business. However, by using these tests, Standard & Poor's has estimated a range of relative risk levels for the various benefit types that are reflected in the revised static charges by benefit type.

Annual Insurance Survey

In 2007, we modified the annual insurance survey we use to support our insurance capital model with input from both clients and leading actuarial consulting firms. We have requested total variable annuity account values, required reserves, TAR under C-3 Phase II, and the New York Insurance Department-based deterministic standard scenario. In addition, we request similar information by living and death benefit rider. The revised static risk charges will depend on the account values by rider. It is understood that the stochastic modeling is done on an aggregated basis and not by rider. However, Standard & Poor's is requesting estimates by rider to better understand the risk distribution. The number of scenarios modeled will also be requested and will contribute to the consideration of incorporating stochastic risk results from C-3 Phase II in lieu of the revised static variable annuity risk charges or the deterministic standard scenario.

Conclusion

Standard & Poor's believes the best way to reflect the risk of variable annuity living benefits in our capital model is through the NAIC's required stochastic C-3 Phase II results. However, when stochastic survey submissions are questionable, new default static charges will apply. The table shows BBB risk factors under the current model and by rating category under the revised capital model. ♂

Long-Term Care: Hedging Your Bet

by Dawn Helwig, Rajesh Bhandula and Nicola Barrett

The demographics are there. The need is there. The products are there. So why haven't the sales of long-term care (LTC) products exploded?

The answer to this question is many-faceted and complex. It includes at least the following:

- The need isn't always recognized ("Medicare or Medicaid will pay." "It won't happen to me," etc.).
- The products are complex and there may be so many options that consumers suffer from "analysis paralysis."
- The companies selling the product have suffered from some instability, in that the players have changed—many have exited—and rate increases have been fairly frequent and often large.

The long-term care product and its administration are complex. Being in the LTC business requires expert knowledge, commitment and understanding of the risks, and a willingness to "gut it out."

Are there tools that can be used to help companies deal with the riskiness of the long-term care product line? This article explores the possibility of using innovations from the financial markets to reduce some portion of the LTC risk and thus encourage the growth of the product.

Background

As stated earlier, the demographics, need and product design all indicate that the stars should be aligned for the success of the LTC product line.

Demographics: While long-term care is not exclusively a product for the elderly—and, in fact, recent sales have trended more to pre-retirees—the risk of needing LTC services increases greatly as a person ages. The well-publicized "graying of America" will stretch public dollars that are available for LTC and will result in greater self-reliance for meeting these needs.

Need: While the probability of becoming disabled enough to need LTC services in any given year varies dramatically by age, sex, marital status and other key factors, various attempts have been made to estimate the lifetime probability of someone needing care. A June 2005 report published by the AARP Public Policy Institute (Cohen, Weingrove, Miller, Ingoldsby) estimated the lifetime probability of developing a disability at 44 percent for males and 72 percent for females. However, not everyone who develops a disability will actually receive long-term care services. Both Milliman and the Agency for Healthcare Policy and Research have estimated that 40- to 45-percent of Americans who reach the age of 65 will require some form of LTC services during their remaining lifetimes. Given the high cost of receiving services (estimated to be in excess of $70,000 per year, nationwide, for nursing home care), the cost of funding even a couple of years of care would deplete the assets of the majority of retirees.

Product: The LTC product has evolved significantly over time, from one that paid for nursing home care only, to today's comprehensive products that pay for care in the insured's home or in an assisted living facility, in addition to a nursing home. Multiple options are available on elimination periods, benefit periods, services covered and ancillary benefits. Return of premium and nonforfeiture options alleviate a person's concern that he will die before needing LTC services. LTC riders are also available to be attached to life insurance and annuity products. In fact, the products available to cover a person's LTC needs are so many and so varied that many argue that some simplification may be needed.

In spite of all this, it is estimated that only about 7- to 8-percent of eligible people over age 55 own a long-term care policy, and—while total policies and premiums in force have been increasing—the number of new long-term care policies sold have been declining in recent years, but have shown a slight increase in the first half of 2007. What has caused the recent lackluster sales?

One reason is that while the need for the coverage has been well documented, that need is something people do not want to think about. There is a general misunderstanding of what the products cover and a denial of the possibility that "it could happen to me." People still tend to think of the policies as "nursing home coverage" and do not want to think of themselves as needing to be in a nursing home. In addition, they often believe that Medicare or Medicaid will cover them, if such a need arises. While it is true that these public programs cover much of the nation's costs of LTC for the elderly today, eligibility for the Medicaid program,

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especially, comes at great cost to an individual, in that assets must be divested in order to qualify, and coverage is often substandard to what private insurance would purchase.

One other reason for the reduction in sales in recent years is that the number of companies selling the product has been declining. In the early 1990s, about 120 companies were selling LTC. In the most recent Broker's World Long-Term Care Survey (July 2007), only 23 companies submitted products to be included. While the total number selling is higher than 23, it is nowhere near the 120 from 15 years ago.

There are a number of reasons why companies have entered and left the LTC market. Some companies determined that the product line took more administrative expertise than they could muster. Some suffered losses from morbidity being in excess of what was expected. Almost all companies have determined that their lapse and mortality rates are significantly lower than they anticipated, resulting in more policyholders persisting into the later policy durations, when claims are higher. (Note: premiums for this policy are issue-age based, and thus are lapse supported.) The drop in investment earnings rates in recent years has hurt companies on earlier policy generations, since significant liabilities have been established for the issue-age rated structure, and those liabilities are now earning less than expected. All companies have also felt the surplus strain of effects from stringent Risk-Based Capital and statutory reserving requirements on the product.

The reinsurance market for LTC has been used in the past to provide some risk relief to companies, but this market has also tightened in recent years.

Key Long-Term Care Risks

There are many factors that affect the profitability of LTC, including age distribution, sex distribution, percent married, benefit options available, proportion of insureds with inflation coverage, discounts offered for preferred risks, expenses, reserve assumptions, margins built in for adverse deviation, etc. However, most LTC actuaries would agree that the three key risks are: 1) morbidity, 2) lapse and mortality and 3) investment earnings.

Because the LTC product is issue-age rated, and because the LTC claim cost slope is very steep, the morbidity cost of the product is heavily back-ended. A new product sold today might have expected loss ratios (ratio of claims incurred to premiums earned) that are less than 10 percent for several years after issue. However, by about the 20th policy year, it is likely that claims paid out will be in excess of the premiums collected. The average payout of claims over the policy's lifetime (on a present value basis, including the effect of terminations) is generally expected to be in the 50- to 60-percent range.

LTC claims levels have varied fairly significantly from company to company, depending on underwriting, claims practices, etc. The underlying probability distribution and potential statistical variation of LTC claims is largely unknown. However, while the likelihood of a 10 percent variation in morbidity is difficult to determine, it's obvious that such a swing would cause a 6 percent swing in pre-tax profit margins (assuming a 60 percent loss ratio), which would put a significant dent in most companies' profit margins.

LTC claims levels have varied fairly significantly from company to company, depending on underwriting, claims practices, etc.

The second key risk on LTC is the termination risk, which can be affected by both voluntary lapsation and the mortality of the policyholders. Both have been significantly lower than originally expected. Voluntary lapse rates have approached levels of 1 percent or less, and mortality has been declining. If ultimate lapse rates were originally expected to be 2 percent and actually end up to be 1 percent, the premium could need to be increased 10- to-20 percent or more, depending on the proportion of the business that has inflation coverage and the average issue age.

Lastly, the interest rate that is earned on the sizable assets that build up on LTC policies will significantly affect profitability and thus present a significant risk for an insurer during times of declining rates. Again, depending on average issue

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age and the proportion with inflation coverage, a one percentage point decline in interest rates could result in premiums needing to be increased 10- to-20 percent.

Looking for hedging solutions for these risks outside of traditional channels may hold the key for addressing some of the issues surrounding the LTC market.

Morbidity and Mortality Risks

The morbidity and mortality risks, which have traditionally been confined to the insurance company portfolios, are now finding their way into portfolios of sophisticated investors like hedge funds. These risks can now be stripped and repackaged into securities that can be sold to investors who have an appetite for this kind of risk. These developments are creating avenues for banks to offer derivative contracts which can offset some of the morbidity and mortality risks in an LTC insurance portfolio.

The most common insurance derivatives in the marketplace are:

1. ***Mortality Swaps.*** These are financial contracts where one party can swap actual mortality rates, typically linked to policies in an insurance portfolio, for expected mortality rates, thus taking out any mortality-related uncertainty in the cash-flow stream. Any deviation from the expected mortality rates is transferred to the party that is willing to absorb the risk for a price. This gives flexibility to the LTC insurance provider to pass off any excess risks in its portfolio to another party, thus creating a more sustainable and competitive business model.
2. ***Cash Flow Swap.*** This is another form of insurance derivatives where the expected payout on an insurance policy at an expected time or over an expected time period in the future can be exchanged for a fixed lump sum amount at a fixed time in the future or now.

These swaps can be tailored to more closely meet the risk management needs of an LTC insurance portfolio.

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Investment Earnings/Interest Rate Risk

An LTC portfolio is typically characterized by mismatches between future cash inflows and outflows. Premiums are received on existing and new policies on an ongoing basis well into the future, which have to be invested in assets that mature around the expected payout dates on these policies. The expected payout dates and the amounts can only be estimated at best in the beginning, but the assets which will be available to invest in the future are not known. In addition, insurers are committed to increasing the benefit amounts by a known fixed rate or by the actual inflation rate derived from the CPI (Consumer Price Index) to adjust for the increase in cost of living. In financial terms, the LTC insurance provider is committed to paying a fixed rate on a forward contract. Interest and inflation rates move up and down with the economic cycles and thus can significantly affect the profitability of the LTC insurance provider.

Financial market innovations can provide solutions to mitigate most of these risks.

1. ***Interest Rate Swaps.*** These are financial contracts between two parties where one party agrees to exchange pre-determined fixed rate interest payments with floating rate (e.g., LIBOR) interest payments on an agreed principal amount for a fixed period of time. These contracts are very commonly traded and are one of the most liquid instruments in the marketplace. They are also available on a forward starting basis where the exchange of payments starts at an agreed time in the future.

An LTC insurance provider can use Forward Interest Rate Swaps to lock in future interest rates. It can then replace these contracts with assets funded by future premiums. The LTC insurance provider also has the flexibility to structure these contracts such that they match the asset/liability profile of their portfolio.

2. ***Swaptions.*** These are options on interest rate swaps, which provide the LTC insurance provider the right to lock-in a fixed rate but not the obligation to do so. The type of swaption typically used is called a "receiver swaption," which is the option to get into an interest rate swap where the buyer receives a fixed rate for a fixed period of time. If the rates rise in the future, the contract will expire at no loss to the insurer and the insurer can buy assets which will yield a higher rate. However, if the rates decrease in the future, the insurer can exercise the option to get into an interest rate swap where it receives a higher rate.

3. ***Inflations Swaps.*** These are financial contracts between two parties where one party pays a fixed inflation rate in exchange for the realized inflation rate for a period of time, thus eliminating any uncertainty related to future inflation. Most LTC products have fixed benefit increases of 3- to 5-percent, supposedly to hedge future inflation increases. CPI has been growing by 3 percent on average for the past 20 years, indicating that products may be over-priced for inflation. Conversely, there is no reason to assume this pattern will continue for the next decades—if inflation floats above 5 percent, current LTC products won't provide enough protection. It's a double-edged sword. More and more LTC insurers are developing products with benefits linked to CPI and the financial market offers the opportunity to completely hedge this risk by using inflation derivatives.

To have a more palatable risk profile, LTC insurance providers can use the products mentioned above as building blocks to develop robust hedging strategies which offset the risks in their portfolios. Employing sophisticated approaches through these products, insurers can offer more competitive and flexible solutions to address the LTC needs of their customers.

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The Chartered Enterprise Risk Analyst Credential: The Experienced Practitioner's Pathway

by Chaundra McGill

The old adage "experience is the best teacher" aptly describes the CERA Experienced Practitioner's Pathway. This pathway is an avenue for a select group of Society of Actuaries members who have demonstrated expertise and substantial experience in the field of enterprise risk management to obtain this new credential without completing the examination requirements.

Short for Chartered Enterprise Risk Analyst, this new international credential encompasses the most comprehensive and rigorous validation available of enterprise risk management. While the CERA curriculum was carefully developed for professionals to use their quantitative and qualitative strengths to bring technical sophistication to a rapidly emerging specialty, this pathway is an opportunity for accomplished professionals to optimize their practical experience to add the CERA credential to their name.

In July 2007, Mike McLaughlin, FIA, FSA, MAAA, became one of the first individuals to earn the new CERA credential, the first new credential from the SOA since it was formed in 1949. While the development of the credential was the work of many members over the past few years, McLaughlin championed its actualization.

McLaughlin notes that while the CERA credential responds to market needs, it also better positions the profession for a competitive future.

Several years ago, McLaughlin realized that today's business world was facing an expanding breadth of risk. While managing and mitigating risk has long been the domain of actuaries, the changing nature of risk now encompassed financial and operational risks. Better known as enterprise risk management (ERM), organizations of all types were taking a 360-degree view of their risk profile, signaling an opportunity for actuaries to become leaders in this emerging practice.

"Soon after I was elected to the Board of Governors of the SOA in 2002, I read that the number of people registering for membership as chartered financial analysts just that one year exceeded the total number of members of the SOA," McLaughlin said. "Clearly the business world was relying on professionals who can convert risk into opportunity. Because actuarial training offers both qualitative and quantitative insights to risk management, I knew our profession was uniquely positioned to play a leadership role in ERM."

With the support of the SOA Board of Governors, the Knowledge Management Strategic Action Team (KMSAT) was engaged to develop a curriculum for a new professional credential. Designed to encompass the most comprehensive and rigorous demonstration of enterprise risk management available, the CERA credential stems from the same rigorous process through which actuaries earn their credentials. Already more than 95 individuals have earned the designation.

"Actuarial principles have traditionally helped the world understand risk, and the CERA credential signifies an evolution of the profession," said SOA Past-President Ed Robbins.

As enterprise risk management has grown to address the increasingly complex needs roles in all types of organizations, including insurance, benefits, broader financial services and the energy, manufacturing, transportation and healthcare industries, many actuaries have already assumed leadership. This CERA Experienced Practitioner's Pathway is for actuaries who have a minimum of three years of substantial experience in the field of ERM.

Qualified professionals interested in pursuing the CERA Experienced Practitioner's Pathway should have relevant experience demonstrated in following ways:

- An individual who has performed work in the field of ERM at a senior level
- An individual who has advanced the actuarial profession within the ERM field
- An individual with significant visibility in the ERM field
- An individual who has made substantial contributions to practice in the ERM field
- Experience as a risk officer for an entity or line of business
- An individual who has served as a key contributor to an organization's risk committee
- Experience managing interactions between multiple risks

- An individual who has developed or implemented methodology for monitoring, measuring and management of risk in an ERM environment
- An individual whose academic research has resulted in practical industry ERM applications

The CERA Experienced Practitioner's Pathway will be open to applicants through July 1, 2008. For more information on the application process, visit www.ceranalyst.org.

McLaughlin notes that while the CERA credential responds to market needs, it also better positions the profession for a competitive future. According to research conducted by the SOA in the past few years, the recognition of actuarial credentials is very high among employers in insurance, reinsurance and consulting markets. Given the increasingly complex and rapidly changing business environment, organizations are now seeking risk management professionals to help manage their companies.

Building upon the profession's inherent rigorous training, the CERA credential provides opportunity beyond "traditional" choices, offers an avenue for differentiation from the competition, and increases actuaries' expertise in risk, enhancing the profession's image in ERM. "The definition of risk is evolving from mere mitigation to expansion of opportunity; CERAs don't merely speak to what we can lose; they focus on what we can gain," said Robbins.

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CERA
Chartered Enterprise Risk Analyst

Currency Risk: To Hedge or Not To Hedge—Is That The Question?

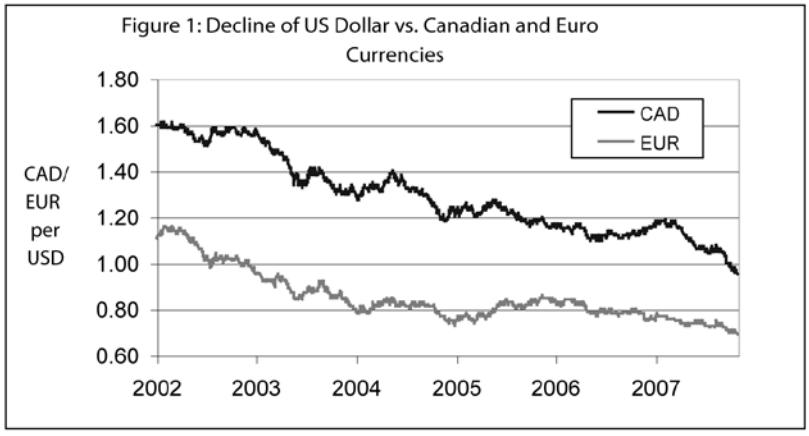
by Steve Scoles

At age six, I started trading currencies. Nothing major—just the British Pound and various Middle-eastern and South Asian currencies. After a few years, I found I could not make consistent profits at FX. So at age nine, in 1981, I shifted to 100 percent fixed income to take advantage of the impending bull market in bonds.

I must admit that story, while mostly true, is slightly embellished. When I was a kid, my family moved from Canada to Saudi Arabia. Because of our various travels in the region, I managed to receive my allowance in about a dozen different currencies. Upon returning to Canada, I converted my life savings back to Canadian dollars. (And invested all $100 in a government savings bond yielding an astounding 19 percent.)

The point of the story is that at a young age I was exposed to a variety of currencies and was sometimes affected, both positively and negatively, by their fluctuating exchange rates.

Now I am in my thirties and working in Asset-Liability Management where currency fluctuations continue to pose problems. Indeed, the last five years have seen some very dramatic currency moves, particularly versus the U.S. dollar. For example, as of October of 2007, the U.S. dollar has depreciated close to 40 percent versus both the Canadian dollar and the Euro since 2002. (See Figure 1.)



Source: Bank of Canada

The Question

In insurance companies and pension plans currency risk arises when a company has future obligations in one currency and investments in another currency. The question that is often asked is whether this currency risk should be hedged or not.

My view is that currency risk should almost always be hedged. Instead of asking whether to hedge or not, the questions that should be asked are: "To make a bet or not to make a bet?" and "Do we truly have the ability to predict currency movements?"

It is important to recognize that a foreign investment involves both a position in the underlying debt or equity and a position in the foreign currency. Leaving currency risk unhedged is really making a bet on that foreign currency.

This article briefly reviews the common arguments against currency hedging and shifts the perspective on taking currency risk. It also gives me a chance to apply my favorite tool for thinking about risk management—the Kelly Formula.

Arguments Against Currency Hedging

The common arguments against currency hedging tend to fall into five categories:

1) The expected return of currencies is zero—so don't bother hedging.
2) We can predict currency movements—so we will actively manage currency exposure.
3) Currencies are mean reverting—the currency exchange rate will come back to where it was.
4) Currency offers uncorrelated risk—so adding currency risk to my portfolio should improve the portfolio's overall risk.
5) Currency hedging adds costs.

The Kelly Formula

Before tackling the arguments against currency hedging, it is useful to review the Kelly formula which I have found to be a great way to think about risk management.

In the 1950's, John Kelly, an AT&T Bell Labs scientist, determined the optimal betting strategy for gambling that maximized the bettor's bankroll expected growth rate.

The Kelly formula was used most famously by mathematician Ed Thorp, who initially applied it to favorable situations in the card game blackjack until he was threatened with harm from the mob-run casinos. He later applied the formula to the financial markets through a hedge fund that has achieved phenomenal long-term returns.

The basic Kelly formula for how much to wager on an even-money bet (a bet where you either double up or lose) is:

> **Fraction of bankroll to wager = 2p -1**
> **(where p = probability of winning)**
>
> For example, let's say you are betting on a fair coin flip. Whether you pick heads or tails, your probability of winning is 50 percent. In this bet, the Kelly formula would say to wager nothing:
>
> **2 x 50 percent - 1 = 0%**
>
> If it was an unfair coin such that heads comes up 60 percent of the time, the Kelly formula says to wager 20 percent of your bankroll on heads:
>
> **2 x 60 percent - 1 = 20%**
>
> And if the coin always comes up heads, you should wager 100% of your bankroll:
>
> **2 x 100 percent - 1 = 100%**

The main idea of the formula is that the size of your bet should be a function of how large your edge or advantage is. If you have no advantage, i.e. like in a fair coin flip, you should risk nothing.

In the investment world, probabilities are rarely exact enough to use the formula with precision, but it does provide a great framework for thinking about risk management. The formula forces you to think about whether you truly have an edge in a proposition and to focus only on situations where you do have an edge.

Argument 1: Expected Returns of Currency are Zero

There have been some historical studies on portfolios of currencies over long investment horizons that have shown currencies on average have an expected return close to zero. Given these historical results, people often view this as a reason to not bother hedging.

However, applying the Kelly formula, if you have an expected return of zero, you should not risk anything. In other words, if you believe currencies have an expected return of zero, it is then a reason to hedge rather than a reason to not hedge. Under this argument, taking currency risk is akin to betting on fair coin flips.

Argument 2: We Can Predict Currency Moves

The Kelly formula does say that if you do have an edge then you should risk some of your capital. So if you do have the ability to predict currency moves with meaningful accuracy, then you should consider taking currency risk. However, the key here is to determine if you truly do have that ability. In reality, many market participants are over-confident in their abilities, making this self-evaluation difficult.

As an example to illustrate this over-confidence, I had a recent conversation with the head of a large equity investment management company. In discussing the merits of a Canadian investor hedging their U.S. dollar exposure, he proudly scoffed, "why would you want to hedge? The Canadian dollar has already made its move." Within six months of that conversation, the Canadian dollar appreciated a further 20 percent against the greenback.

I am not using this example to prove that hedging was the correct action to take because of what happened subsequently. Rather, I am using it to illustrate the dangers of over-confidence when dealing with financial markets. As financial writer Jason Zwieg puts it, "we're even over-confident about our ability to overcome our own overconfidence!"

Argument 3: Currencies are Mean Reverting

The mean reversion argument bears similarities to both of the above arguments, but it deserves special attention. Mean reversion is the idea that while currencies will fluctuate, they will return to a mean level over a long-term horizon. This argument tends to show up in the real world with phrases like: "the currency is hitting long-term highs, it's due for a pull back" or those famous last words in finance, "it can't go any lower than this."

While I agree that it appears markets have a tendency to overshoot appropriate levels from time to time, I do not think mean reversion follows as a rule. If the market is mean reverting, it is probably often reverting to a future unknown mean rather than a past calculable mean.

One of the starkest examples against reversion to the mean in currencies is how the British Pound fared against the U.S. dollar in the 20th century. Up until about 1940 or so, the British Pound was the world's reserve currency (before the U.S. dollar took over). From 1935 to 1985, the pound sterling declined almost 80 percent versus the greenback. (See Figure 2.)

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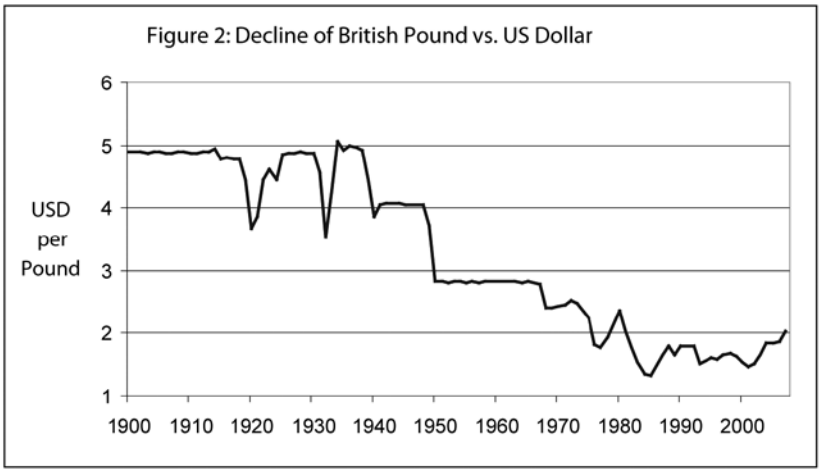

Perhaps there is someone out there born in the 1930's who will live long enough to see the pound sterling mean revert!

Source: *Lawrence H. Officer, "Exchange rate between the United States dollar and the British pound, 1791-2004." Economic History Services, EH.Net, 2005.*

Argument 4: Currency Offers Uncorrelated Risk

The idea that uncorrelated risk is good comes from the mean-variance framework of modern portfolio theory. In the context of looking at only assets, that may be fine. However, it is important to remember that insurance companies and pension plans are highly leveraged propositions. Our long-term guarantees to policyholders and plan members require us to measure risk vis-à-vis the liabilities rather than simply looking at the assets. That is, asset value fluctuations are not important as long as the liability value fluctuates in the same way. In this asset-liability context, currency risk adds to the overall risk rather than reduces it.

Argument 5: Currency Hedging Adds Costs

The implementation of a currency hedge involves derivatives which add costs (and counter-party risk). Rather than view these costs as part of the hedging decision, they should be viewed as part of the overall evaluation of the foreign investment. If the costs of currency hedging outweigh the benefits of the underlying debt or equity instrument, then the foreign investment should simply not be done.

Conclusion

When it comes to currency risk, the crucial error people make is to ask the wrong question: to hedge or not to hedge. Instead, the questions that should be asked are: "To make a bet or not to make a bet?" and "Do we truly have the ability to predict currency movements?" For most, leaving currency risk unhedged is akin to betting money on coin flips.

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Hedging Interest Rate Risk in Traditional Life and Health Products

by David Wang and Craig Reynolds

Profitability of traditional life and health products has long been considered less sensitive to changes in interest rates than profitability of universal life, SPDAs, or other "interest-sensitive" products. Consequently, traditional products have often been priced with a single deterministic interest scenario. Some type of sensitivity test is often reflected, but few companies price such products on a full stochastic basis.

Recently, Milliman completed a research project for the Society of Actuaries on "Interest Rate Hedging on Traditional Health and Life Products." The results of this research are available on the SOA Web site at www.soa.org/files/pdf/rsrch-interest-rate-hedging.pdf.

In this article, we summarize our key observations and analysis. Interested readers are encouraged to review the report or contact the authors for further information.

Our analysis indicates that a pricing run of a hypothetical plain vanilla regular premium non-par whole life product over multiple stochastic interest rate scenarios can demonstrate far more profit volatility than one might expect, depending on the investment strategy employed. The distribution of the profitability has rather fat tails on both sides.

The table below shows the distribution of profits for our sample product, assuming that all assets are invested in cash and that there is no interest-sensitive policyholder behavior. Similar results were observed when we performed the same analysis on a typical long-term care product.

Statistical Measures of Profits

	PV of Pre-Tax Book Profits	Profit Margin
Mean	$ 670,385	10%
Standard deviation	$ 435,070	6%
Minimum	($ 265,307)	-4%
Maximum	$1,918,077	27%
Quartile 1	$ 344,741	5%
Median	$ 656,761	9%
Quartile 3	$ 940,135	13%

We believe that a good measure of interest sensitivity can help the user when judging how to hedge or manage the interest rate risk of the product. Perhaps the most widely used measure of interest sensitivity is duration, the measure of percentage change in asset or liability market value when interest rates move. However, our analysis shows that duration might send conflicting or confusing messages to the user when ongoing premiums are reflected in the analysis.

If regular premiums are netted from liability cash outflows in our sample, then the duration of the net liabilities is negative at policy inception, implying that assets with negative duration should be desired for asset liability management.

Alternatively, if regular premiums are moved to the asset side and calculated separately, the duration of both liability cash flows and premiums is positive, though the duration of the premiums is much shorter than the duration of the associated liability outflows. This implies that assets with very long positive durations should be desired for asset liability management. This apparently conflicting message makes it difficult to interpret the duration measure.

As an alternative, our research proposes using DV01. DV01 measures the dollar amount change in the value of assets/liabilities when interest rates move by one basis point. DV01 has two advantages over duration. First, it gives a consistent message, irrespective of whether premiums are deducted from liabilities or moved to the asset side. Second, it measures dollar amount change, which is exactly what matters from a hedging perspective.

The idea behind managing the DV01 of the insurance product is to find assets that offer the same amount of DV01 as the embedded liabilities of the insurance product. Our analysis shows that by simulating DV01 hedging, the change in market value of the surplus arising from the insurance product is almost eliminated when the interest yield curve

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changes by a small degree. DV01 hedging becomes less effective when the size of the change in the yield curve gets bigger or when the shape of the yield curve changes. This is not unexpected because DV01, by definition, works only when interest rates change by one basis point and when the entire yield curve shifts in parallel. While we did not address the convexity problem arising from the larger changes in the yield curve, we do suggest that one can compensate for the change in shape by analyzing dollar partial durations.

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Dollar partial durations measure dollar amount changes in the value of assets/liabilities when each of the selected term-to-maturity points on the yield curve changes in turn. In our analysis, we looked at two-year, five-year, 10-year, and 30-year dollar partial durations. When we modified our hedge simulation such that each of the four dollar partial durations was matched between assets and liabilities, the change in the market value of surplus was greatly reduced for scenarios when yield curves changed by a larger degree or when the shape of the yield curve changed.

The table below summarizes the standard deviation of the market value of surplus across the multiple stochastic interest rate scenarios over the first six projection years for four different investment strategies.

- ***Strategy 1:*** All assets are assumed to be in cash account.
- ***Strategy 2:*** All assets are assumed to be in a representative mix of bonds and mortgages, with the objective of enhancing investment yields rather than hedging.
- ***Strategy 3:*** Hedge assets are simulated to match DV01 of the liabilities.
- ***Strategy 4:*** Hedge assets are simulated to match the four dollar-partial durations of the liabilities.

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Cash only	$289,131	$506,341	$618,574	$737,305	$769,614	$832,017
Mixed pool of assets	$280,666	$469,804	$565,504	$655,525	$676,842	$713,500
DV01 hedge	$ 36,320	$ 47,968	$ 59,993	$ 78,516	$ 98,992	$115,122
Dollar partial duration hedge	$ 11,152	$ 25,110	$ 41,266	$ 60,690	$ 48,460	$ 51,930

This table clearly illustrates that the use of the DV01 hedge can greatly reduce the standard deviation of the market value of surplus across scenarios.

Apparently, traditional life and health products are indeed sensitive to changes in interest rates. With the DV01 or dollar partial duration measures we introduced in our paper, the user could manage the interest rate risk of the products on an economic basis. However, our analysis shows that the same management on an accounting basis would appear less effective because the statutory basis for reserves is currently not sensitive to interest rate changes. Nonetheless, we believe it is still vital for the industry to understand the interest rate risk of the traditional life and health products and consider the appropriate management measure of such risk. This is perhaps more critical as the industry moves toward principles-based accounting or fair value accounting.

Implementing Asset/Liability Management— A User's Guide to ALM, LDI and Other Three-Letter Words

by Anton Wouters

Editor's note: In September, ABN AMRO Asset Management held seminars on Liability-Driven Investing in Montreal, Toronto and Vancouver, Canada. Previously this article was published in the November 2007 Institutional Newsletter of ABN AMRO.

As we meet with pension plan sponsors and consultants across Canada we find that the subject of liability-driven investing (LDI) comes up repeatedly (even when we do not initiate the discussion). We also find that LDI seems to mean something different to each person we meet. Is LDI just a new name for asset/liability management (ALM)? Or is LDI just about hedging interest rate risks with fancy securities? Or is LDI something else again? In this article we describe a framework for understanding what LDI is, how it relates to ALM, and how it can be used to solve real-life problems for Canadian pension funds.

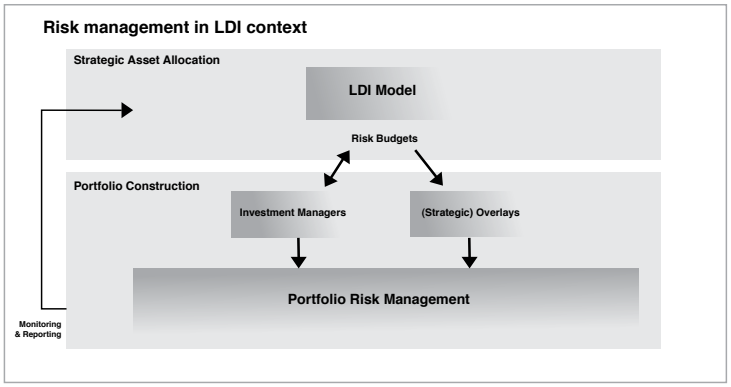
LDI as a Wider Risk Management Concept

By linking the plan's strategic asset mix to its liabilities, asset/liability management provides the foundation for the actual investment processes used by the plan. In our view, liability-driven investing is an approach to organizing those investment processes to manage plan-specific risks.

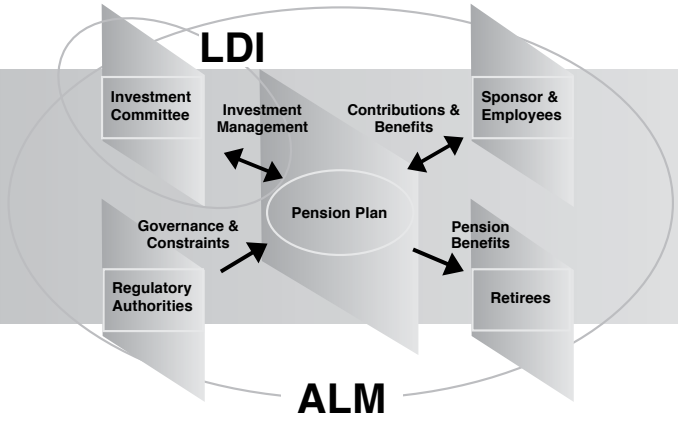
The outcome of the plan's ALM study is the input to the LDI strategy. LDI is a process for finding the "best" way to implement the ALM study's recommendations.

By linking the plan's strategic asset mix to its liabilities, asset/liability management provides the foundation for the actual investment processes used by the plan.

In this context, "best" means first defining what constitutes risk for the pension plan and then using a structured approach to managing that risk (or those risks) in the most effective manner. In order to do this, it is necessary to consider the plan's strategic beta exposures (i.e., its asset allocation and its interest rate sensitivities), the role of active management in providing additional, possibly non-correlated, returns, and the possible use of dynamic strategies to react to changing market conditions and pension fund characteristics.



An important point in this context is that using an LDI approach does not have to mean any significant changes to the overall investment strategy—rather it is a way of optimally implementing that strategy—so LDI can thus be combined very readily with the pension fund's overall view of active management. (Due to space limitations, we will not explore the active management aspect in further detail in this article.)



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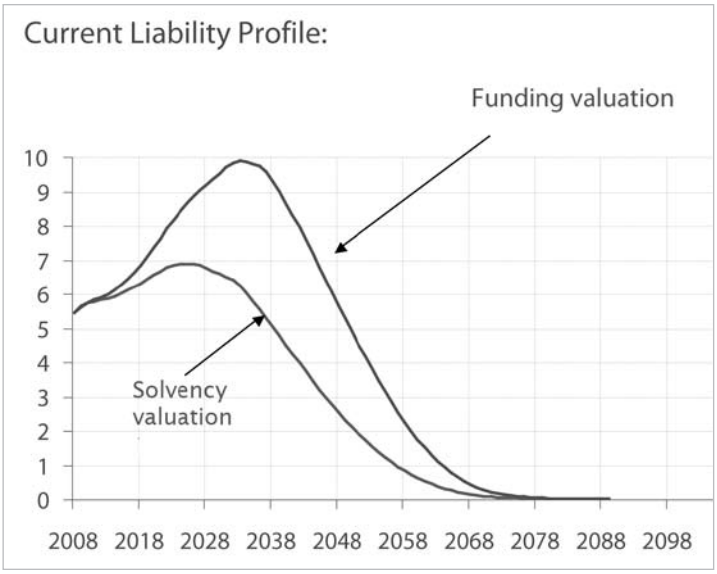
A Canadian Example

As an example, consider a typical Canadian corporate-sponsored defined benefit plan. Based on today's plan membership, this plan has liabilities representing an annual benefit payout stream stretching decades into the future. Because of Canadian pension rules, the plan's management and their actuary must in fact consider more than one future payout stream, as shown in the next chart: One stream will be based on the benefits accrued to date as if the plan was being wound up, and will be used for the solvency valuation. The other stream will take into account future benefit increases and accruals (based on the actuary's estimates) and will be used for the going-concern or funding valuation.



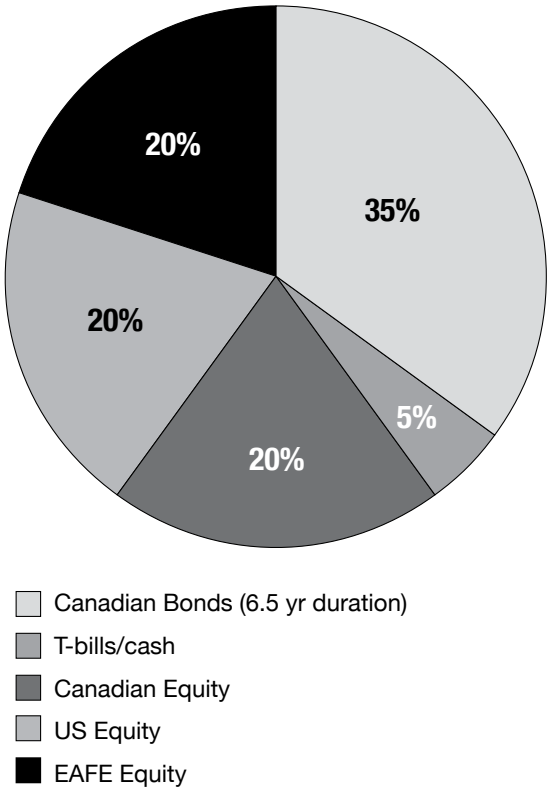
The plan in question has assets of $100 million (market value) and funding liabilities of $108 million, resulting in a funded ratio of 93 percent on a going-concern basis. The plan's solvency liabilities are $118 million, and so the solvency ratio is 85 percent.

Comparing the valuation results to the payout chart above may raise the question of why the lower solvency payouts generate a higher liability value. The answer of course lies in the discount rate used to calculate the present value of the payout streams. For solvency valuations, actuaries must use current long-bond yields, while funding valuations use an estimate of the plan's expected long-term investment returns. The discount rates and other valuation characteristics are shown in the table below:

Characteristics	Funding Valuation	Solvency Valuation
Discount rate	6.5%	4.4%
Asset value	100	100
Liability value	108	118
Funding ratio	93%	85%
Duration of liabilities	15	15

Based on an asset/liability study, this typical plan has, not surprisingly, a typical asset mix, shown below:

Current Asset Mix



What are the Risks Associated with this Plan?

One risk might well be the risk of a sizable drop in the solvency ratio over the next year, as this would have unpleasant consequences for the sponsor and possibly the members. By conducting Monte Carlo simulations it is possible to quantify this risk, as shown in the table below:

Characteristics at a 1-Year Horizon	Funding Valuation	Solvency Valuation
Expected funding/ solvency ratios	97%	90%
Lower bound of 95% confidence interval	81%	71%
Expected return of asset mix	6.6%	6.6%
Tracking error versus liabilities	10%	12%
Probability funding/ solvency ratio declines more than 10%	6%	9%

Looking at the "Solvency Valuation" column, we see that the **expected** solvency ratio for the plan a year from now is 90 percent (the increase from the present 85 percent is due to the plan receiving expected investment earnings and amortization payments). However, the bottom line of the table shows that there is a 9 percent chance that the solvency ratio will have fallen by more than 10 percent, to below 75 percent—a most undesirable outcome. Indeed, the second line of the table shows that there is a 2.5 percent chance that the solvency ratio will be as low as 71 percent. The expected increase is nice, but the risk of a bad outcome is significant enough that the plan sponsor may well wish to adjust the management of the plan.

Reducing the Solvency Ratio Risk

1. ***Increase Duration***

As a first step in trying to reduce the risk of a drop in solvency, the plan could increase the duration of its bond portfolio to bring it into line with the 15-year duration of the liabilities. Re-running the simulations shows that increasing the duration this way would leave the expected solvency ratio a year hence at 90 percent, and would also decrease the probability of a drop of more than 10 percent to 7 percent from the previous 9 percent—a modest move in the right direction.

2. ***Increase Bond Allocation***

To build further on the improvement above, the plan could also increase its allocation to bonds from 35 percent to 50 percent. In conjunction with the increased duration, this reduces the likelihood of a drop of 10 percent or more in the solvency ratio to 3 percent. However, because more of the portfolio is now allocated to bonds, the portfolio's expected return falls from 6.6 percent to 6.0 percent and the expected solvency ratio falls from 90 percent to 89 percent. So although the risk of a truly adverse event has been significantly reduced, there was a cost involved: the expected solvency situation of the plan, and thus its ongoing cost, have both deteriorated slightly.

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3. ***Use Interest Rate Swaps***

Using interest rate swaps instead of changing the plan's bond portfolio is a way to adjust the plan's interest rate sensitivity without significantly affecting the plan's underlying assets and hence its expected return. By using an interest rate swap overlay instead of steps 1 and 2 above we find that we are able to maintain the plan's expected solvency ratio in a year's time at 90 percent and its expected return of 6.6 percent, while delivering a 5 percent likelihood of a drop in solvency of more than 10 percent. While this last statistic is not as favourable as in item 2 above, it still represents a great improvement over the other cases we have examined so far.

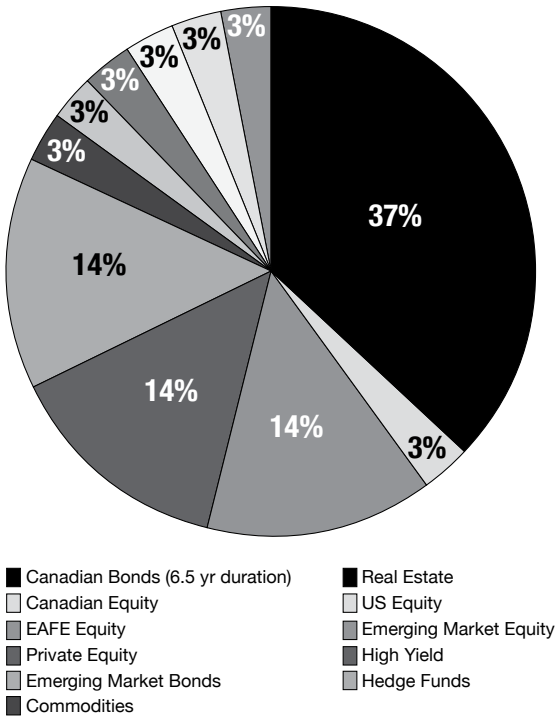
The results of these three possible actions are set out below in detail:

Characteristics at a 1-year horizon	Current Mix	Increase Duration FI	Increase Both Duration & Allocation to FI	Interest Rate Swaps
Expected solvency ratio	90%	90%	89%	90%
Lower bound of 95% confidence interval	71%	73%	76%	75%
Expected return of asset mix	6.6%	6.6%	6.0%	6.6%
Tracking error versus liabilities	12%	11%	8%	10%
Probability solvency ratio declines more than 10%	9%	7%	3%	5%

While doing this alone has very little impact on the likelihood of a 10 percent or greater drop in solvency—it reduces it from 9 percent in our base case to 8 percent—by combining this diversification approach with the interest rate swap overlay of item 3 above, we are able to reduce this risk to 3 percent while maintaining our expected return of 6.6 percent and our expected solvency ratio of 90 percent, as shown in the last column of the table on top of page 27.

4. ***Diversify the Asset Mix***

A different step the plan could take would be to diversify its asset mix, including such asset classes as private equity, emerging market equity and bonds, hedge funds and so on, while staying close to the broad asset mix developed in the asset/liability study. One possible mix is shown here:



Characteristics at a 1-year horizon	Current Mix	Interest	Diversification	Combination
Expected solvency ratio	90%	90%	90%	90%
Lower bound of 95% confidence interval	71%	75%	72%	76%
Expected return of asset mix	6.6%	6.6%	6.6%	6.6%
Tracking error versus liabilities	12%	10%	11%	9%
Probability solvency ratio declines more than 10%	9%	5%	8%	3%

Thus, by identifying the risks the plan wishes to manage and allocating risk budgets accordingly between a strategic overlay and a broader asset mix, our LDI approach has helped to reduce the risk while maintaining the expected return of the asset mix that was the outcome of the plan's asset/liability study.

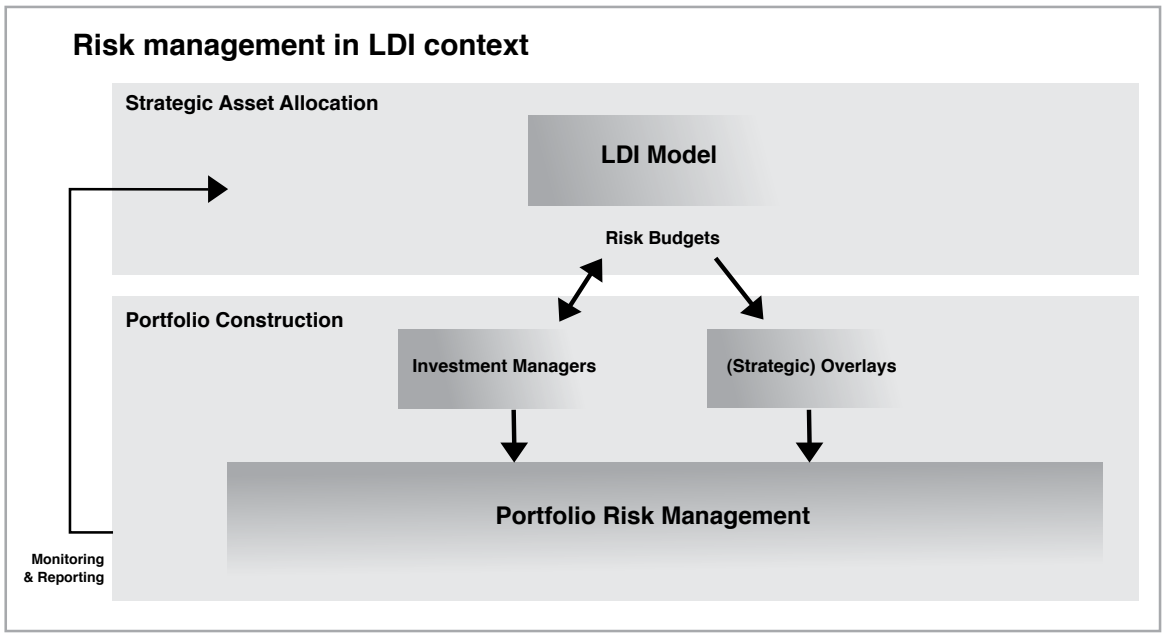
Dynamic LDI

All of the analysis in the example above occurred as at a single point in time. However, markets and plan liabilities shift over time. As our risk framework below suggests, the LDI manager will monitor these changes and adjust the portfolio structure accordingly.

In practice, this means considering the total portfolio as a combination of two sub-portfolios:

- A portion that is used for hedging purposes relative to the liabilities of the plan; and
- A portion that is used to generate upside potential strong enough to keep the pension expense within reasonable bounds.

Under this dynamic LDI approach, the manager increases the commitment to higher-yielding assets when the solvency level is higher, while increasing the commitment to the hedging portfolio when the solvency level is lower. In the Canadian context, it would also make sense to reduce the commitment to the higher-yielding portfolio again once a targeted



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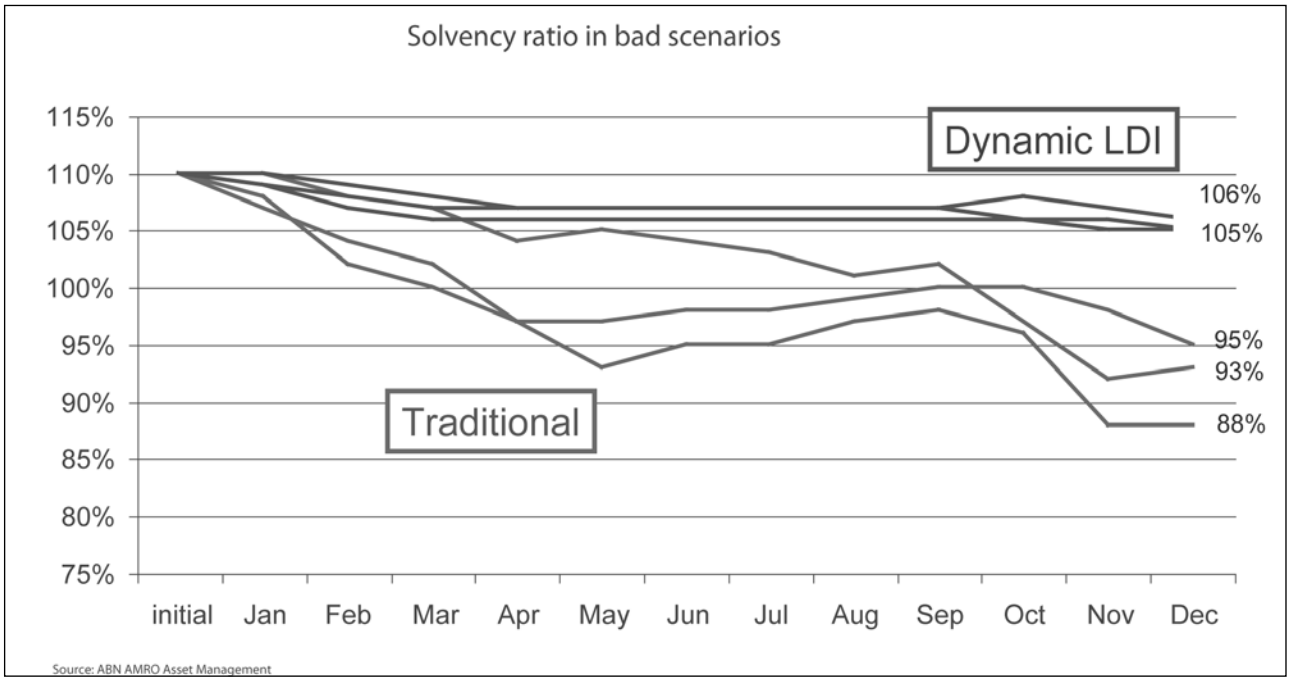
solvency level is neared in order to avoid building too large a surplus.

The ability of dynamic LDI to keep solvency ratios within a relatively tight band even in bad markets is illustrated below.

Conclusion

Liability-driven investing is a risk management framework for implementing asset/liability management. Beyond interest rate hedging, LDI also incorporates strategic asset allocation and risk budgeting, portfolio construction, and ongoing risk monitoring and reporting. It does not necessarily imply a major overhaul of the portfolio, and it can be implemented in more than one way.

In addition, LDI can provide a framework for incorporating appropriate active management into the portfolio, a subject we have not discussed in this newsletter due to space limitations.



Note: *All charts, diagrams, tables and statistics are sourced from ABN AMRO Asset Management. Past performance may not be repeated.*

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Hurry! Don't miss your chance to share your comments with the SOA Board on the CPD Requirement Exposure Draft. The comment period, launched in November 2007, will close on February 22, 2008. Comments and feedback from members, candidates and other interested parties received to date have helped us develop new FAQs. All feedback is critically important and will be considered at the June 2008 SOA Board meeting. Please send your questions or comments to *cpdcomments@soa.org.*

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