Article from:

The Financial Reporter

May 1999 – Issue 39

A Framework for Managing Surplus

by David N. Becker

The historical focus of actuaries has been the liabilities. In more recent times it has expanded to include asset/liability management. The last frontier is surplus and, while some might not think surplus to be in the actuaries' province, there are significant advantages to utilizing the holistic, integrative and value adding skills of actuaries in the management of surplus. This is especially true when the actuaries have added finance and investment expertise to their already extensive knowledge base concerning the identification, assessment and management of risk. Such expertise can be gained from the education curriculum for the Chartered Financial Analyst designation granted by the Association for Investment Management and Research and the curriculum developed by the Society of Actuaries for its speciality in finance and investment at the Fellowship level. This paper presents a comprehensive framework for the management of the surplus of an insurance enterprise that is built from these knowledge bases.

The role of surplus is to provide the insurance enterprise a source of funds for growing new business, protection against adverse liability market experience (obligation risk), protection against adverse capital market experience and protection against business environmental risks, changes in tax laws or the competitive playing field. To do this, surplus needs its own risk/return requirements and appropriate diversification. Although surplus is a single concept on the balance sheet, it is not often that simple in the real world. As many companies have segmented asset portfolios to support specific liability portfolios, the tendency is to associate a portion of surplus with each liability portfolio. This lack of a unified surplus portfolio can have significant downside implications, specifically economic suboptimization and operational suboptimization.

When surplus assets are spread into many portfolios and, typically, combined with assets supporting liabilities, economic suboptimization can result from less diversification. This is due to inability to accurately control exposure to different asset classes, sectors and individual security names that are maintained in many different portfolios instead of a single portfolio. It makes it difficult, if not impossible, to have an investment strategy for surplus. In such a fragmented environment there usually isn't an investment strategy for surplus but, instead, there are many strategies that may default to investing each of the "surplus's assets" similarly to the strategy used for the liabilities the surplus supports. This last possibility is clearly suboptimal, as investment strategies for liability portfolios should reflect the liability's liquidity needs, return requirements for competitiveness, profitability, liability crediting strategy and asset/liability management requirements. Other suboptimizations include potential for lower returns, higher transaction costs and higher credit risk.

Operational suboptimization occurs from the higher cost structure for financial management, financial reporting confusion and score keeping errors, greater difficulty in accurately rebalancing portfolios, potentially inconsistent treatment for handling defaulted securities and using surplus as the hidden shock absorber for liability portfolio mistakes.

The proper management of surplus is facilitated by having a holistic framework for the management of the firm. This top-down analysis provides the structure from which appropriate decisions about managing surplus can be made. Such a top-down analysis requires a metric on which to measure firm results, a liability portfolio rebalancing method (accounting structure), an asset allocation strategy and a monitoring process. The asset allocation strategy is determined using modern portfolio theory.

The metric we use is the value of the firm, i.e., the risk-adjusted present value of the firm's free cash flows. For a U.S. life insurance company, the free cash flows are the amount that can be paid to shareholders or distributable earnings. Thus it requires appropriate recognition of Statutory Accounting Principles in the United States.

Separate "liability portfolios," i.e., assets supporting a given product line, should be maintained where risk characteristics materially differ. The risk characteristics may be either liability-specific or company/competitor-specific. Examples of the first are: guaranteed cash values, partial surrenders and policy loans; permanent and temporary floor interest rate guarantees; premium flexibility; fund transfer options; target market differences; tax or non tax-qualified liabilities; differing distribution channels; and crediting strategies. Company/competitor examples include investment and disinvestment strategies and the "competitor" interest crediting strategy.

The liability portfolios should be rebalanced monthly. Certain liabilities, such as equity indexed annuities, should be rebalanced more frequently to ensure the proper hedge is maintained. The liability portfolio "book value" equals: statutory reserve, plus liability portfolio interest maintenance reserve, less policy loans, less the net of receivables less payables. The book value of assets supporting the liability should equal the liability portfolio book value. Note that other than incidental noninvested assets (e.g., the net of receivables less payables) the assets supporting the associated liabilities should be real invested assets. One should not rebalance the portfolio with statutory goodwill, even if it is an admitted asset.

The portfolio structure for an insurance enterprise should consist of the appropriate number of distinct liability portfolios and a surplus portfolio. We recommend that the surplus portfolio should comprise two portfolios. The first portfolio is the main surplus portfolio which may or may not include the asset valuation reserve of the company. The second, and smaller of the two, acts as a cash management account from which the liability portfolios and the first, or principal, surplus portfolio are rebalanced on a monthly basis. Because this second account acts as a cash management account, it should have a "cash management account" investment strategy. From this point on, references to the surplus portfolio refer to the principal surplus portfolio.

An investment policy statement is needed for the surplus portfolio. This will provide the portfolio description, investment objective, a strategic asset allocation strategy, tolerance for each asset allocation class, a tactical asset allocation strategy and a list of any constraints.

The strategic asset allocation strategy represents the base line investment strategy (i.e., an asset allocation strategy that company management would be comfortable holding throughout an entire business cycle). This strategy should be reviewed on a periodic basis or whenever client conditions or capital markets experience significant change. The tactical asset allocation strategy indicates temporary deviations from the strategic asset allocation that are allowed due to changed conditions in the then-current capital markets. The allocations under tactical management are subject to the tolerance limits established as part of the investment strategy.

There is a need for a wide array of asset classes. Diversification is achieved only by investing in multiple asset classes having low or negative correlations. This reduces systematic risk or volatility of the surplus portfolio without negative effects on portfolio return. The choice of many classes may enhance returns in addition to risk reduction. Note that some classes have punitive risk-based capital requirements. These may drag down the performance of the entire portfolio when the cost of holding additional assets for the classes' default risk are considered. The risk reduction potential must be weighed against this burden.

The surplus investment strategy consists of objectives and constraints. The objectives include the return objective and the risk tolerance. The constraints include liquidity needs, time horizon, taxes, legal and regulatory constraints and any special circumstances the company has.

The liquidity constraint can be expressed as a given percentage of surplus, e.g. 5% or 10%. This liquidity serves as a secondary source of liquidity for liabilities, the first being the liability portfolio itself. (Note that the "cash mangement" surplus account also provides some liquidity.) Other liquidity constraints might be having liquid A. M. Best assets greater than or equal to some percentage of surplus. The same is true of liquid Standard & Poor's assets. Given that implementing a new investment strategy may require significant shifts in asset allocations, there might be limitations on the allowable increase or decrease in an asset class. These limits may be based on the yearly production rate or disposal rate for each class, respectively. (The presence of the production/disposal limits may mean that it might take more than one year to move from a given asset allocation to an optimal asset allocation.) Finally, there might be a constraint against shorting any asset class.

The time horizon constraint for surplus should be the decision of management with due input from the investment professionals. The horizon should reflects management's risk tolerance.

The tax constraint should reflect federal income taxes, taxes on realized gains and losses, limitations on loss carry-forwards and carrybacks, and applicable state income taxes.

Legal and regulatory constraints include the domiciliary state investment law, including any "basket" provisions and any extra territoriality effects if the company operates in New York.

While there may be many items in the special circumstances constraint, several that apply to insurance enterprises are: minimum desired NAIC risk-based capital (RBC) ratio; capital asset ratios from A. M. Best, Standard & Poor's, Moody and Duff & Phelps; and Standard & Poor's "risky" assets ratio.

One should also be alert for unusually negative biases against a specific asset class held by any of the rating agencies. Management may also have a minimum requirement for current income on the surplus portfolio. Because surplus assets are finite and the assets supporting surplus have their own default risk-based capital requirement, one must specify as constraints both the total amount of surplus and the amount of surplus that is "free" in that it can be used to cover the risk-based capital requirements for the assets backing the surplus portfolio. (The part of surplus that is not "free" surplus is set equal to the risk-based capital requirements for all of the liabilities and their supporting assets.) The more "free" surplus the surplus portfolio has, the more risk-based capital intensive the entire surplus portfolio can be. This would mean the more risky and, therefore, supposedly higher returning assets could be chosen for the surplus portfolio than would be the case if "free" surplus were smaller.

The typical risk measure is the standard deviation of portfolio total returns. A more sophisticated (but more difficult) measure is the portfolio's semi-variance or second lower partial moment. This measure captures only the downside variation of portfolio returns from the expected value or a specifically chosen floor return level. The risk tolerance is linked

"Diversification is achieved only by investing in multiple asset classes having low or negative correlations."

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to the time horizon and should consider at least a "minus two sigma" event's impact on both the market value of surplus and the book value of surplus. The risk tolerance must be chosen by management with due input from the investment professionals.

The return objective must be chosen by the client. With due regard for the client's constraints and risk tolerance examples of different return objectives are to maximize:

1. after-tax total return on invested assets;
2. after-tax total return on invested assets subject to a floor on current income;
3. current income on invested assets subject to a floor on after-tax total return; and
4. current income; and
5. net risk-adjusted spread (please see Appendix A for description).

Again, each of these are subject to the client's constraints and risk tolerance.

The goal is to find the efficient portfolio that satisfies the client's constraints and meets the client's investment objectives. This can be done by finding the optimal asset allocation based on the investment objective for each of several levels of portfolio risk, which is computed as the standard deviation or volatility of the portfolio's total return. This will require quadratic programming as the portfolio risk is a second-order relationship with the risk characteristics of each asset class. The asset class opportunity set must be defined. For each member of the set the expected total returns (mi sub sergi), standard deviations or volatilities (si sub sergi) of total returns and correlations (rij si sub sergi) between total returns must be specified. Output should be examined for sensitivity to these input values.

The expected returns, volatilities and correlations should be determined on an ex ante basis, i.e., they should be based on future expectations, not on an ex post or historical basis. In practice, recent historical estimates for volatilities have been found reasonable for use on an ex ante basis, historical correlations are somewhat less reliable, and use of historic estimates for means has been poor.

The means of total return and standard deviations or volatilities of total returns for the fixed income asset classes reflect a "view" of the interest rate environment over the time frame of the projection since changes in market value are part of total return. When the equity classes are considered, these analogous values represent a view of the equity market returns and volatility. The correlations reflect the joint volatility of fixed income and equity markets. The portfolio standard deviation reflects the volatility of the market value of the portfolio. Using standard deviation as the measure of portfolio risk for each of the choices of objective function named previously (whether or not the objective involves total return), places limits on the change in market value due to volatility in the debt/equity markets when considered along with the expected total return of the portfolio resulting from the optimized asset allocation.

It is tempting to include as a constraint the durations and convexities of the various asset classes. But care must be taken so that the duration and convexity values are consistent with expected total returns and their volatilities as the latter two values reflect the investment professionals view on how the debt markets might move due to interest rate changes.

In the quadratic programming model, each constraint is reflected in a specific inequality. For each level of risk, the following information is computed:

1. a vector of asset allocations for the asset class opportunity set;
2. expected after-tax total returns;
3. current income;
4. Sharpe ratio (ratio of excess portfolio expected return over risk-free rate to the portfolio's standard deviation of expected return);
5. after-tax return on equity;
6. after-tax operating return on equity; and
7. surplus levels for one, two and three sigma events.

From this output, management can make a decision as to the risk/return trade-off and choose the optimal asset allocation strategy.

Two computational issues that might arise are sensitivity of optimization software and the "knife-edge" problem. The first issue involves the need to be aware of any limitations in the software's ability to solve the quadratic programming problem. Some software programs have more superior solution algorithms than others. Later generations of the same program may have significantly increased capabilities. The knife-edge problem can cause the vector of asset allocations to change dramatically for small changes in the level of risk. This can also cause the model to excessively emphasize certain asset classes. The model must be reviewed for robustness and modified by judgement in the event of this type of problem.

Once the strategic asset allocation strategy has been identified, tactical asset allocation decisions can be made if the investment advisor has confidence in a special view of the capital markets at a given time. The ability to make tactical asset allocation decisions must be allowed by the investment policy statement and such tactical decisions can be evaluated by use of performance attribution techniques. As the surplus portfolio evolves over time, consideration needs to be given to a surplus portfolio rebalancing strategy. Finally, the strategic asset allocation should be reviewed annually or whenever client circumstances and/or capital market expectations change.

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Appendix A Net Risk Adjusted Spread (NRAS)

Suppose two or more securities are available for purchase by the portfolio manager using available cash in either a liability portfolio or a surplus portfolio. How might the portfolio manager evaluate the securities so as to rank order them by preference? One proposal is the net option-adjusted spread described below.

It is assumed at the outset that any security under review already meets the criteria ("filters") for the applicable portfolio (surplus or liability) according to the portfolio's investment policy statement constraints and its strategic asset allocation and/or the tactical asset allocation based on then current conditions in the capital and liability markets. The net option-adjusted spread (NRAS) is the net reward offered by the security after reflecting several security-specific costs to the insurance enterprise. For a given security define:

Gross Spread (GS)
For noncallable bonds and mortgages, GS is the difference between the yield on the given bond and a Treasury of similar duration. For callable pass-throughs, collateralized mortgage obligations (CMOs), commercial mortgage-backed securities (CMBSs), collateralized bond obligations (CBOs), asset-backed securities (ABSs), etc., it is the spread-to-Treasuries of similar duration computed without consideration of the impact of the embedded option.

Cost of Embedded Option (CEO)
A reduction to the GS to reflect the cost of any embedded options, (e.g., call options, prepayment options).

Default risk cost (DRC)
The cost (in basis points) for expected defaults.

Liquidity Cost (LC)
An estimate of the liquidity cost of a given asset, (i.e., a function of the bid/asked spread).

Investment expenses (IE)
The level of investment expenses per unit incurred for a security in that asset class, on a marginal basis.

Risk-based Capital Cost (RBCC)
The risk-based cost of capital (CoC) for that security, i.e. if the CoC is the firm's cost of capital, RFR is the risk-free rate and X is the RBC requirement (e.g. NAIC, A. M. Best, Moody, Standard & Poor, Duff & Phelps) as a decimal, then RBCC = (CoC - 0.65 x RFR) x X. (RFR is used as a simplifying assumption where the added assets to support RBC are assumed to be invested in Treasuries.)

Net Risk Adjusted Spread (NRAS) = GS - CEO - DRC - LC - IE - RBCC.

Many insurance companies evaluate an asset on the basis of gross spread without adjustment for the embedded option less expected defaults. This ignores the facts that (1) the security may contain embedded options whose presence may cause the gross spread to be overstated relative to other securities; (2) one security may have a higher expected default than another and thus have a higher spread; (3) different asset allocation classes have different expense levels, and failure to reflect such level may lead to incorrect comparisons; and, (4) some assets carry high RBC penalties and the excess return may not fully compensate for the additional capital consumed.

There are circumstances when the cost of embedded options term may be reduced. For example, if the proposed asset for purchase supports a liability with flexible interest credits, in which credits could be reduced in the event of a decline in interest rates (where a bond would be called or mortgage-backed security prepayed thus reducing portfolio yield), then a part or all of the cost of embedded options could be ignored.

When evaluating alternative securities for purchase, the NRAS enables a quantitative comparison among them that simplifies the decision. Recall that this assumes that each of the securities is acceptable from the perspective of an appropriate investment for the liability portfolio or meets the surplus portfolio asset allocation strategy, respectively.

The quantity, GS - CEO, equals the option-adjusted spread (OAS) where such spread may be computed from an option pricing model based on default free Treasury securities. For some securities it is easier to directly measure the OAS. (The Treasury rate is that for a Treasury security of the same option-adjusted duration as the given security. If duration matching is the specified asset/liability management strategy, then the option-adjusted duration is equal to the target duration of the liability portfolio that the asset is to support or the target duration for the surplus portfolio if one has been specified. For a liability portfolio, the duration of the security may differ from the target duration either by conscious decision or if the actual duration of the portfolio is to be adjusted by means of the purchase of a security with a different option-adjusted duration.)

As a result, the net option-adjusted spread may be restated as:

NRAS = OAS - DRC - LC - IE - RBCC.

The cost of purchasing a new security (as opposed to a trade) should be omitted unless there is a significant difference between the various alternatives. Note: there is some indication that instead of the Treasury of similar duration one should use the swap curve.

Issues Relating to Trades

The following is an initial list of issues that should be considered when trading assets within either a liability portfolio or the surplus portfolio. It is assumed that any trade would be within the strategic asset allocation and current tactical asset allocation guidelines for the portfolio.

1. Differences in gross spread
2. Differences in cost of embedded options
3. Differences in expected default costs

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4. Differences in asset class specific expenses
5. Differences in RBC requirements
6. Cash flow differences between the two securities
7. Transaction costs
8. Capital gains tax implications
9. Impacts on interest crediting rates, if applicable. There is also the issue of who (i.e., policyholders or shareholders) should benefit from the transaction, and to what degree.
10. Impact on interest maintenance reserve (IMR) and any applicable statutory accounting considerations
11. Impact on GAAP accounting results Note that realized gains in liability portfolios go to GAAP surplus and do not remain within the liability portfolio. For example, realizing gains on assets supporting a fixed liability effectively advances the timing of GAAP operating income but changes its character into net income instead of operating income. The future GAAP operating income will be lower and the margins in the GAAP reserves will be lower. If the realized gains are too large, then the liability portfolio has negative GAAP margins that would result in loss recognition. This is the worst situation, because not only has the future operating income been converted into net income, but the realization of gains beyond the point of a zero margin results in negative operating income via the loss recognition.
12. Rating agency issues, if any.

David N. Becker, FSA, PhD, CFA, is Vice President and Chief Actuarial Officer, Lincoln National Life Insurance Company, Fort Wayne, Ind. This article appeared in The North American Actuarial Journal, and is being repeated here because of its pertinence.

Value-at-Risk—an Overview (Part Two of Two)

by Glyn Holton

(Editor's Note: Issue 38 of The Financial Reporter, January 1999 contains Part One of this article, dealing with a definition of VAR, a simple model of it, key factors in VAR and discussion of linearity and non-linearity aspects.)

Simulating VAR

Faced with non-linear portfolios, we must discard the linearity and normality assumptions of delta-normal VAR and consider alternative approaches to estimating VAR. The basic problem of estimating VAR, however, remains the same. We consider a set of key factors whose behavior we can describe statistically. We have a portfolio price function that relates those key factors to the portfolio's price. Somehow, we must translate these two pieces of information into an estimate of the portfolio's VAR. In this section, we consider the problem as one of solving an integral equation.

Suppose we wish to estimate 95% VAR for a portfolio. The portfolio's VAR is the bound on a 95% confidence interval for ΔP. As suggested by Exhibit 1, this can be expressed as an integral:

$$95\% = \int_{-VAR}^{\infty} p \, d\Delta P \qquad [21]$$

where p is the probability density function for ΔP.

In [21] we are not actually solving for the value of the integral. Instead, we are solving for the value VAR that makes it 95%. If no closed form solution exists for [21], we consider numerical methods of integration. In doing so, we face a problem called the "curse of dimensionality." This arises because, although [21] is presented as a one-dimensional integral, it is in fact an m-dimensional integral—both p and ΔP are functions of the m key factors.

$$\{V_k\}_{k=1}^{m}$$

Most techniques of numerical integration entail dividing the area of integration into subparts, performing some simple calculations on each subpart, and summing the results.

A problem in multi-dimensions is that, as the number of dimensions grows, so does the number of (multi-dimensional) rectangles used. For example, in the one-dimensional case, the area of integration [*a*,*b*] might be divided into 100 subparts. In the two-dimensional case, the area of integration has the form [*a*,*b*]5[*c*,*d*]. If both the intervals [*a*,*b*] and [*c*,*d*] are divided into 100 subparts, there are going to be 1002 = 10,000 rectangles to evaluate.

In the 50-dimensional case, that number grows to 100^{50}. Reducing the number of subparts into which each interval is divided does not help. In the 50-dimensional case, if each interval were divided into just two subparts, this would translate into 2^{50} = 1,125,899,906,842,620 rectangles.

This is the "curse of dimensionality." It is a problem that causes most techniques of numerical integration to fail when applied to high-dimensional problems. It is an issue with VAR because many portfolios are exposed to tens or hundreds of key factors—each one adding a dimension to the problem.

Monte Carlo simulation is a form of numerical integration that avoids the curse of dimensionality. Using the numerical approach outlined above, the integral is approximated as:

$$\int f(x)dx \approx \sum_{i=1}^{z^n} A_i \qquad [23]$$

where z^n is the total number of rectangles, and A_i is the area (volume) of the i^{th} rectangle. Because of the sheer number of rectangles involved, we do not directly calculate this sum. Instead, we note that