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Excess Spread Approach to Pricing and Valuing SPDAs

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Abstract

The purpose of this article is to introduce the reader to the excess spread approach to measuring the profitability of nonparticipating insurance products. A sample Single Premium Deferred Annuity (SPDA) product is used to demonstrate the approach. The article describes how the excess spread approach is used to price and manage the product, measure its risks, and to quantify emerging profits or losses by source.

Excess Spread Approach

The most natural approach to the management of many interest sensitive insurance products is to think of them as spread lending businesses. One strives to have enough spread between the earning power of assets and the cost of one's liabilities to cover expenses and provide adequate profit. The simplest way to measure this spread is to subtract the credited rate on the liabilities from the rate being earned on the assets. However, this approach is as dangerous as it is simple because it ignores the value of interest sensitive product and investment features that are often present. As a result, the simple approach usually gives a "best possible case" profitability calculation, rather than a best estimate.

The purpose of the excess spread approach is to provide a measure of the profitability of an insurance product on a spread basis and to incorporate the expected value of any options inherent in the assets and the liabilities into that spread. The first step in the excess spread approach occurs at the time of product pricing, when the required spread on assets is calculated. This is the spread over Treasuries that must be earned in order to satisfy the liability payments. The excess spread is then calculated to be the excess of the spread being earned by the assets over the required spread on assets. Both the required spread on assets and the spread being earned on the assets can be, and must be, adjusted to reflect the value of embedded options so that the excess spread represents the expected profitability of the product.

At the time of product pricing, or at any later point in the life of the product, the exposure of the excess spread to any number of risk factors can be measured. These risk factors will include:

1. Market conditions:
   (a) interest rates
   (b) interest rate volatility
   (c) demand/supply for different types of assets
2. Policyholder actions:
   (a) surrender
   (b) death
3. Insurer actions:
   (a) resetting of credited rates
   (b) expenses incurred

Periodically through the life of the product, the excess spread can be recalculated to measure the overall economic performance of the asset and liability portfolios. Also, excess spread techniques can be used to measure ex-post the contribution of different sources to changes in profitability.

Asset/Liability Management

Background

With the increase in interest rate volatility beginning in the 1970s there came a growing awareness of the importance of measuring market values to determine the true economics of a portfolio of assets and liabilities.

Measuring the market value of assets proved to be the easier of the two, due to the existence of a secondary market for most fixed income securities. However, there is no liquid secondary market for insurance company liabilities, which has proven to be a stumbling block for the liability side of the market value approach.

Asset Side Developments

The increase in interest rate volatility also caused fixed income investment managers to become much more aware of the value of options embedded in many of the assets they held, such as callable bonds and mortgage backed securities. At the same time, the emergence of exchange traded option contracts introduced a new tool to fixed income portfolio management. As a result, considerable time and effort has been spent, both within the investment community and in academic circles, in developing option pricing techniques for fixed income assets.

One of the tools fixed-income managers needed was a measure of value that could be used to compare the expected return of one callable asset to another callable asset or to a noncallable asset. Such a measure has come into general usage and is known as the option-adjusted spread. The option-adjusted spread is calculated as follows for callable bonds.

Step 1. The callable bond is recognized to consist of an underlying noncallable bond and a call option owned by the issuer of the bond.

$$\text{Callable Bond} = \text{noncallable Bond} - \text{Call Option}$$

Therefore, if we let $P(\cdot)$ represent the price function, then

$$P(\text{Callable Bond}) = P(\text{Noncallable Bond}) - P(\text{Call Option})$$

The call option price has a negative sign because the option has in effect been sold by the holder of the bond to the issuer.

This call option enables the issuing entity to buy the bond back from the holder at a specified price schedule over a specified period of time. The original buyer of the bond is compensated for issuing the option by receiving a higher coupon than an otherwise identical noncallable bond would pay. The higher coupon, as well as the existence of the call provision will be factors in the subsequent price behavior of the callable bond.

Step 2. The price relationship can be rearranged as follows:

$$P(\text{Noncallable Bond}) = P(\text{Callable Bond}) + P(\text{Call Option}).$$

The price of the callable bond can be observed in the marketplace and the call option premium can be calculated using an option pricing model. The market, by the level at which it prices the callable bond, is actually implying a price for the underlying noncallable bond.

Step 3. Given the implied price of the noncallable bond, one can calculate its yield to maturity. The implied yield of the noncallable bond is defined as the option-adjusted yield on the callable bond—the yield received net of the value of the call option sold to the issuer. The option-adjusted spread of the callable bond is the difference between the option-adjusted yield on the bond and the Treasury yield corresponding to the duration of the noncallable bond (interpolation may be necessary).

The decision to exercise the call option for a particular bond issue is made only once by a financially sophisticated individual, the corporate treasurer, unlike the situation for mortgage backed securities (MBS). MBSs convey the principal and interest payments from a pool of residential mortgages. Individual mortgage holders ordinarily have the right to prepay their mortgage without penalty regardless of where interest rates are. This right, or option, is not exercised as efficiently as the call option in the callable bond. Often, homeowners will prepay their mortgages for reasons other than refinancing with a cheaper mortgage, when it would not appear to be economically feasible. Also, some homeowners will not prepay when their mortgage carries a much higher than current rate, and it would seem advantageous to refinance. In general however, mortgage prepayments do tend to increase as interest rates go down. Other factors that affect mortgage prepayment behavior are the age of the loan and its prepayment history, as well as seasonal tendencies. As a result of the "path-dependence" of MBS cash flows, one needs a set of interest rate paths and a cash flow generator to calculate an option-adjusted spread for a MBS.

It is important for actuaries to gain some understanding of how option-adjusted spreads on MBSs are calculated, not just because they represent a large asset class but because they have similar characteristics to an SPDA (which will be discussed in detail later in the article). Both instruments contain very long-dated options to prepay or surrender at a fixed price. In both cases these options are exercised with only partial efficiency. Changes in the option-adjusted spread are frequently used by portfolio managers to measure the performance of different MBSs relative to Treasuries.

The excess spread technique uses the same tools to calculate what spread above Treasuries is needed for a given market value of assets to satisfy certain liabilities.

The option-adjusted spread is the measure of the earnings power of an asset (relative to Treasuries) after accounting for the value of any embedded options. Without making the adjustment to asset yields for the value of call options, one would be overstating the true earnings power of the asset by including the yield inducement received by the lender (the insurance company) for providing the call option to the borrower.

Liability Side Development

If there were a market value of insurance company liabilities, one could compare it directly to the market value of assets or use it to calculate an option-adjusted spread on the liabilities. Because in the vast majority of cases there is no unambiguous market value of liabilities, another approach must be adopted. One can use what is known, the market value of assets, to calculate the required spread on assets, or RSA. The RSA represents the spread over Treasuries that must be earned on the assets in order to satisfy the liabilities. The RSA is calculated as follows.

1. Calculate the market value of the asset portfolio as of a certain date.
2. Calculate the Treasury forward rates as of the same date.
3. For interest sensitive liabilities, develop a set of Treasury interest rate paths.
4. Calculate liability cash flows and expenses. For non-interest-sensitive liabilities, this will be simply a vector of cash flows corresponding to different points in time. For interest sensitive liabilities, this will be a matrix of cash flows, one for each future period of time along each interest rate path.
5. Determine the spread which, when added to the corresponding Treasury rates (vector or matrix), will discount the liability cash flows (vector or matrix) to the market value of assets. This spread is the RSA.

SPDA Example

An SPDA is chosen to demonstrate the excess spread approach because it involves an option in the policyholder's hands—the surrender option, and an option in the insurance company's hands—the ability to reset interest rates.

Pricing

The first tool that will be needed for pricing the sample SPDA product is a set of Treasury interest rate paths. For this application each path will consist of a short-term (three-month) Treasury rate, as well as a three-year coupon Treasury rate at each time interval (quarterly) over the 24 year period being studied. Arbitrage-free conditions dictate that the means of future three-month and three-year rates are implied by the term structure of the prevailing U.S. Treasury yield curve at the time of pricing. As a result of complying with the arbitrage-free conditions, one can use the set of paths to price financial instruments, the importance of which will be demonstrated shortly. The deviation of rates from their future expected levels is assumed to have a lognormal distribution. Given a volatility assumption for three-month and three-year rates, and their correlation, one can generate normal deviates that will allow calculation of the yields required at each point in time along the entire set of Treasury interest paths. This can be done in such a way that each path is equally likely. The simple arithmetic average of the discounted values of the cash flows for the various paths gives the fair price of the cash flow stream.

The stepwise development of the sample SPDA product with each line representing one step is shown in Table 1. For each step, four figures are shown:

1. RSA: The required spread on assets is calculated as the spread that must be added along each path to the short term Treasury rates to discount the liability cash flows to the market value of assets. The RSA represents the borrowing cost of the liabilities as a spread over Treasuries. The RSA is expressed in terms of basis points where 100 basis points equals 1%.
2. Marginal Effect on RSA: This column shows the marginal effect on RSA of the feature introduced on that line.
3. Interest Rate Duration: The interest rate duration is calculated by "shocking" the initial Treasury rates up and down, calculating a new set of interest rate paths for each shock, and calculating new present values of the liability while holding the RSA constant. Typically, the shocks are parallel shocks to the forces of interest, but nonparallel shocks could be used if desired. The interest rate duration is the percentage change in the present value of the liabilities for a shock of one percent (100 basis points) in the initial Treasury rates.

TABLE 1
REQUIRED SPREAD ON ASSETS:
SPDA PRODUCT WITH $30,000 SINGLE PREMIUM

	Description	RSA (bp)	ΔRSA (bp)	Interest Rate Duration (years)	Mean Term (years)
1	Three-year Treasury	0	—	2.6	2.6
2	"Bare Bones" SPDA	0	0	2.6	8.7
3	"Bare Bones" SPDA with different base withdrawal assumptions	0	0	2.7	10.6
4	Deduct $1,800 of up-front commissions	63	+63	2.6	10.3
5	Deduct $300 of up-front expenses	74	+11	2.6	10.2
6	Add annual renewal expense of $100	102	+28	2.7	10.0
7	Collect surrender charges upon policy lapse	85	−17	2.7	10.2
8	Credit 50 bp below three-year Treasuries	35	−50	2.7	10.2
9	Include interest sensitive surrenders	58	+23	2.3	7.5

4. Mean Term of Liabilities: The mean term of liabilities is the Macaulay duration (present-value-weighted time to maturity) averaged over the set of interest rate paths. The RSA is added to the short term Treasury rates for this calculation. Only for products where there are no interest sensitive withdrawals and the credited rate on the product does not change, will the interest rate duration and the mean term be equal. The mean term of liabilities helps to give one a feel for how long the business is on the books, and can be used as the appropriate time period for amortizing certain expenses.

Line 1. In line one the insurance company hypothetically issues a current-coupon three-year Treasury bond at its current market price of $100. Projecting the cash flows from the liability along all the interest rate paths is trivial because they are simply the coupons and principal repayment of the three-year Treasury and are independent of the path. In this case, if one adds a spread of 0 to the short term Treasury rates along each path, the cash flows discount to the market price of the assets—hence the RSA is zero. The assets are the single premium received for the policy, which is assumed to be $30,000. The interest rate duration and mean term of this simplified liability are the same, equal to that of the three-year current-coupon Treasury bond. This trivial case demonstrates why following the arbitrage conditions in building the interest rate paths is essential. The model indicates that investing the proceeds from the sale of this product in three-year Treasuries would eliminate interest rate risk (duration match) and provide sufficient earnings power (RSA=0) to back the product. (Note that there are no expenses and no profit target at this point). This is the result one would expect intuitively. Sets of paths that do not meet the same criteria can give very different results.

Line 2. The second line shows a "bare-bones" SPDA. There are still no expenses, no profit target, and no surrender charges. On this SPDA product, the current three-year Treasury rate is guaranteed for three years. At the end of three years, the credited rate is reset to the then-prevailing three-year Treasury rate for the next three years and so on at each subsequent three year point. The model assumes that there is an annual "base" lapse rate, equal to the credited rate. At the end of 24 years (eight reset periods), any business that remains is assumed to lapse.

The lapse assumption and credited rate assumption have been chosen such that the SPDA product being offered at this point is really nothing more than a three-year Treasury that rolls every three years. It is simple intuition that rolling three-year Treasuries every three years in the asset portfolio will give an earnings and duration match for this product. Thus one would expect the model to give an RSA which is zero and an interest rate duration that is the same as the three-year Treasury bond, which it does. There is now a much longer mean term of liabilities because the business is "on the books" for a much longer period due to the reset procedure. This example clearly demonstrates that for a product with a rate reset like the SPDA, the interest rate duration (sometimes known as the price sensitivity duration) is the proper measure to use for asset management purposes, not the mean term of liabilities.

Line 3. This line is the same "bare bones" SPDA product, but with a base withdrawal assumption of 6% per year for the first ten years and 10% thereafter. This results in no change in the RSA, a very small change in the interest rate duration, and an increase in the mean term of liabilities due to an overall reduction in lapse rates.

Line 4. The fourth line is the first of a number of pricing steps. This line includes the effect of deducting $1,800 of commission expense from the $30,000 of single premium. One must now add a (positive) spread to short term Treasury rates in order to discount the liability cash flows to the new, lower market value of assets. The increase in RSA of 63 basis points means that one has to earn an additional 63 basis points above Treasuries to recoup the commission expense. In fact, even though this number appears to come out of a black box, a shortcut method for estimating it will be very intuitive to actuaries. One first expresses the commission expense as an average percent (6.19% = $1,800/($30,000 – .5*x*$1,800)) of the single premium, and then in effect amortizes it over the average mean term of the liabilities, to get 63 basis points. Since the RSA is expressed on a bond-equivalent or semiannual basis, the mean term must be "semiannualized" to do the estimation, much the same way that Macaulay duration measures for noncallable instruments must be modified to estimate the price change attributable to a specified change in semiannual yields.

Line 5. Here other noncommission up-front expenses of $300 per policy are deducted. These expenses are deducted separately because unlike commission expenses, they will probably depend to some extent on the volume of business written, and knowing their marginal effect may be valuable later on.

Line 6. This line shows the effect of adding an annual renewal expense of $100 per policy. This expense will probably also depend to some extent on the volume of this product that is written.

Line 7. One feature that will reduce the RSA is the early years' surrender charges which will be collected when policies are surrendered. This sample SPDA policy has a surrender charge scale of 7%, 6%, 5%, 4%, 3%, 2%, 1% for the first seven years, and then 0% for the remainder of the life of the policy. The policyholder has a guarantee on return of principal. Line 7 shows the effect of collecting these surrender charges.

It is interesting to compare the cost savings of surrender charge revenue against the increased cost due to expenses, because it is often hoped the two will offset.

An alternative to a fixed percentage surrender charge scale is to base the charge on the current interest rate being credited to the policy: for example, half of a year's interest. Introducing surrender charges of this type tend to increase the duration of the product, because when interest rates (and therefore credited rates) go up, surrender payments to policyholders are reduced to a greater degree than when rates go down.

Line 8. The assumption that three-year Treasury rates would be credited initially and on all the reset dates was just a starting point for demonstrating the model. In fact the insurer has decided to credit 50 basis points less than the three-year Treasury both initially and on all reset dates. Line 8 shows that the RSA calculation produces exactly the intuitive effect when this change is made, a cost reduction of 50 basis points.

Line 9. In this line interest sensitive surrenders are introduced. It is assumed that whenever the credited rate falls too far below prevailing new money rates for SPDAs, assumed to be 50 basis points below three-year Treasuries, there will be interest sensitive surrenders in addition to the base surrenders. The policyholder is presumed to make his/her surrender decision based on the ability to recover surrender charges over a three-year period. So, in the fifth year, when the surrender charge is 3%, it would take a spread between the policy's credited rate and new money rates of at least 1% before interest sensitive surrenders would begin to occur. Interest sensitive surrenders are assumed to be six times the square of the rate gap that exists beyond the surrender charge amortization threshold (expressed as a percent). So if a rate gap of one percent existed, interest sensitive surrenders of six percent would result. A rate gap of 2 percent would cause interest sensitive surrenders of twenty-four percent. Interest sensitive surrenders are capped at 30% per year.

In some SPDA products, a portion of the account value can be withdrawn each year free of surrender charges. This portion of the business may therefore exhibit different surrender behavior than the part on which surrender charges would be levied, and should be modelled accordingly.

Introducing interest sensitive surrenders into the model is how one can incorporate disintermediation risk into product pricing and asset management targets. The increase of 23 basis points in the RSA shows that there is definitely a "cost" to disintermediation. Taking account of interest sensitive surrenders also results in a lower interest rate duration. Also, increased surrenders lead to a lower mean term of liabilities.

There are really two components to the marginal cost of 23 basis points. One is the option cost, the effect of higher lapses in higher interest rate environments. The second is the effect of amortizing the up-front expenses over a shorter period of time in higher interest rate environments.

An important input to the generation of the set of interest rate paths is the assumed level of future interest rate volatility. Higher assumed volatility will increase the value of disintermediation risk and a lower volatility assumption will decrease it. Also, using different diffusion processes for interest rate changes can affect the expected value of disintermediation risk. The value shown in this example can be thought of as an expected cost figure. The actual disintermediation cost will be higher or lower depending on the path interest rates take and the level of surrenders that occur.

There are a number of other product features that have been ignored in this example such as minimum rate guarantees and commission recovery on early lapses. A number of SPDA products have a market value adjustment clause applying to surrenders that is designed to protect the insurer against disintermediation risk. The excess spread technique can be used to test whether the market value adjustment is properly designed. If the market value adjusted product is well designed, altering the interest sensitive surrender and interest rate volatility assumptions will not change the RSA significantly. Increasing or decreasing the overall level of surrenders may change the earnings target even with a market value adjusted product because surrender charge revenue may not offset expense amortization.

Measuring Risk

One can measure the risks that affect the SPDA product by measuring the exposure of the excess spread to various risk factors. The change in excess spread caused by the change in a risk factor provides a relative measure of risk that can be compared against the expected profit and also against the other risks that are present.

Interest Rate Risk

Assume that one is able to buy acceptable credit quality noncallable bonds that have an interest rate duration of close to 2.3 years and a spread of 120 over Treasuries. The bonds are investment grade and the insurance company's credit analysts feel that 5 basis points is the appropriate deduction from the yield for credit risk. This asset (ABC bond) gives the following expected profitability picture when used to support the sample SPDA product:

	Basis Points
Spread on Assets	120
less Credit Risk	–5
less Required Spread on Assets	–58
Excess Spread	57

In this case a callable bond is held, so the nominal spread of the bond over Treasuries of 120 basis points can be used in this calculation. In cases where there are options involved in the asset, the option-adjusted spread should be used in the expected profitability calculation.

If 57 basis points is an acceptable profit margin, one might proceed by measuring the interest rate risk of such a strategy. Interest rate risk can be studied by measuring the effect on excess spread of parallel shocks in interest rates. The first step would be to select the shock levels to use, and to calculate the new market value of the asset position at each shock level. For a noncallable bond such as the ABC bond. the market value calculation is relatively easy. The second step is to generate a set of interest rate paths for each interest rate shock, in order to calculate the RSA. This produces the analysis shown in Table 2.

Table 2 is a good example of how sometimes a simple duration matching strategy can give very good results within a certain range of interest rate changes, but unacceptable results outside the range. Other risks can be studied in a similar fashion using the excess spread technique.[1]

Policyholder Surrender Risk

In pricing the SPDA product, an assumption as to policyholder surrender behavior was made using both base surrender and interest sensitive surrender components to lapse rates. The sensitivity of the RSA to different surrender assumptions should be tested. This testing may be nothing more than doubling and halving the interest sensitive component. Often it is assumed that when interest sensitive surrenders first occur there is a one-time jump in the surrender rate. Another possible approach is to start the analysis with two groups of policyholders, a "hot-money" group and a "cold money" group, and apply different surrender functions to each one.

Sometimes the results of testing different surrender rate functions can be surprising. One should remember that interest sensitive surrenders represent policyholder exercise of a very long dated option and that surrender charges usually are higher in early years than later on. Therefore, quick exercise of the withdrawal option as soon as it is slightly advantageous to the policyholder does not always lead to the most expensive (highest RSA) result.

Expense Risk

Lines 5 and 6 in Table 1 give a good guide as to the cost effect of changing the up-front and ongoing expense assumptions. It may be instructive to calculate the effects on up-front and periodic expenses, and therefore on the RSA, of higher and lower than assumed sales volume—namely, of different per policy expense assumptions. Similarly, it is important to study the effect of different average policy size assumptions.

TABLE 2
INTEREST RATE RISK

	Change in Interest Rates				
	−3%	−1%	0%	+1%	+3%
Market Value of Assets	$29,857	$28,537	$27,900	$27,278	$26,078
Spread on Assets (bp)	120	120	120	120	120
less Credit Risk	−5	−5	−5	−5	−5
less RSA	−66	−59	−58	−58	−86
Excess Spread	49	56	57	57	29

TABLE 3
DIFFERENT CREDITED RATE RESET STRATEGIES

Reset Strategy	RSA (bp)	Interest Rate Duration (years)	Mean Term (years)
Static Reset Strategies			
1. Reset completely to new money rate (pricing assumption shown in Table 1)	58	2.3	7.5
2. Reset to two thirds of the new money rate and one third of the previous credited rate	60	2.6	7.1
3. Reset to one third of the new money rate and two thirds of the previous credited rate	74	3.2	6.8
Dynamic Reset Strategies			
1. Follow the new money rate 100% if rates go down but only 50% if rates go up	38	2.5	6.9
2. Same as above, except 25% up if within the surrender charge period and 75% up if beyond the surrender charge period	33	2.6	6.7

Optimal Crediting Strategies

One should also study the effect of different crediting rate reset strategies. Rather than resetting the credited rate completely to new money rates (three-year Treasuries minus 50 basis points) on every reset date, one could adopt a strategy of resetting a rate that is a fixed percentage of the difference between the new money rate and the previous credited rate. It is also possible, using the excess spread approach, to test more dynamic strategies: a few of which are shown in Table 3.

The first three lines show that for this sample product and the surrender behavior assumed in Table 1, that following new money rates less closely gives a longer interest rate duration but a shorter mean term. Following new money rates less closely makes the policy "behave" more like a longer term financial instrument, and causes the business to run off the books more quickly (shorter mean term) due to higher interest sensitive surrenders. In this situation, following new money rates completely produces a lower RSA than resetting rates one third or two thirds of the way towards new money rates.

The question of what is the best way to reset rates is also a question of to what extent the insurance company is willing to take advantage of inefficient policyholder behavior. Depending on the surrender rate function, it is possible that not following rates completely when they rise may reduce the cost of the product. At a certain point, the savings of crediting less to those policyholders that stay more than offsets the cost incurred by those that surrender in a higher rate environment. A couple of dynamic reset strategies that lower the RSA are shown in Table 3. The lower RSA of the dynamic strategies is evidence of the value of the insurance company's option—the option to reset rates differently based on the path of interest rates, and the prevailing surrender charge.

One could also test the effect on RSA of different sales volume resulting from more or less aggressive credited rates. Higher volume of sales would decrease initial and periodic expenses to some extent, but these savings would presumably be at least partly offset by the more aggressive initial (and perhaps renewal) rates necessary to generate that volume. One may want to test the RSA effect of different combinations of commission, surrender charge, and initial credited rate, if these variables have not been fixed. It may be possible to calculate a number of "RSA neutral" combinations of commission, surrender charge, and initial credited rate, and let the marketing arm of the insurance company choose the final product from among them.

However, one should keep in mind that the strategy with the lowest RSA is not necessarily the best strategy. Different asset option-adjusted spreads (OASs) may be achievable at different sales volumes and at different durations. For example, higher OASs may be achievable for lower sales volume through the ability to put a larger proportion of the asset portfolio into attractive, but scarce, high-yielding private placements.

Also, different asset OASs may be available at different durations simply as a market phenomenon in the bond market. To pick an optimal strategy, one might prepare a table that would look something like Table 4.

TABLE 4

EXCESS SPREAD CALCULATION*

Sales Volume†	Liability Duration		
	2 Yrs	2.5 Yrs	3 Yrs
$100,000,000	125 –63 62	125 –65 60	135 –77 58
$200,000,000	115 –58 57	115 –60 55	125 –72 53
$300,000,000	110 –70 40	110 –72 38	120 –84 36

* The calculation shown is: Asset OAS (net of credit risk) minus RSA, equals the Excess Spread.

† Different sales volumes assume a credited rate spread of 70, 50, and 30 basis points below Treasuries respectively, initially and upon renewal.

Liability duration management is possible because, as shown previously, liability duration is a function of reset strategy.

If the goal is to maximize total excess spread, and not per unit excess spread per dollar of business, one must multiply each of the excess spreads calculated by its corresponding volume. Surplus considerations will probably also affect the level of sales volume that can be considered.

Measuring Experience

Suppose that it is now one year after issue and one would like to measure the experience on the block of business. One would like not only to measure the overall experience, but also to get a feel for the respective contributions to the overall performance from a number of sources.

Asset Performance

The first comparison is between the spread at which it was assumed one could invest and the actual option-adjusted spread at which investments were made. The actual initial spread on assets establishes an excess spread for comparison against actual results.

One year later the path that interest rates have taken since the policy was written is known. To measure the contribution to profitability of asset performance, one does not need to know anything about actual liability behavior—one merely presumes that the liabilities behaved as assumed in pricing, given the interest rate environment that actually occurred. One begins by measuring the market price at the end of the year of the amount of ABC bond that would be held if the liability had behaved as assumed. This involves surrendering the appropriate percentage of the block of policies based on the assumed surrender rate function and the actual path of rates, and then deducting one year's expected profits, expenses, etc. Next, one recalculates the RSA based on these liability assumptions and asset performance. A new set of interest rate paths based on current interest rate levels will have to be generated in order to project the liabilities and calculate the RSA. The change in RSA that results from this calculation can be ascribed to asset performance over the year. One of the contributing factors to this change is the movement of rates and the relationship between asset and liability durations. Interest rate sensitivity testing—at the time of pricing should avoid big surprises here. Other possible contributing factors include: any spread change on the ABC bond; the realization of the credit risk charge (unless the bond defaulted or was downgraded), and the effect of any changes in the market's implied volatility assumption if the asset involves options.

Liability Performance

The liability performance component of the overall profitability results is measured by the change in RSA as a result of using actual liabilities rather than assumed liabilities. The major component of this performance will likely be the degree of surrenders experienced. Depending on the level of rates and the surrender charges collected, the surrenders will have a positive or negative effect on the RSA. Unfortunately, it will take a number of observations of surrender experience in different interest rate and surrender charge environments to draw any conclusions about the appropriateness of the originally assumed surrender rate function.

Other Contributors to Performance

There are a number of other possible contributors to the overall performance of the block of business. One can measure the marginal contribution of each by measuring the change in RSA caused by incorporating that aspect of experience into the RSA calculation. For example, using actual versus assumed expenses shows the effect on profitability of expense misestimation. of course, expense misestimation can derive from a number of sources such as misestimation of volume, average size, actual costs, or allocation of expenses among lines of business. Expense (and for that matter surrender) experience may also cause one to rethink the assumptions used for future periods. Changing assumptions during the lifetime of a block of business will also have an effect on the RSA and hence on expected future profitability.

Another aspect of insurance company behavior that must be monitored is the resetting of credited rates. Resetting to a higher or lower level of rates than assumed at the time of pricing will interact with the surrender experience and may cause incremental profits or losses. Any change in reset strategy from the one assumed at the time of pricing should be reflected immediately in the RSA calculation.

Summary

The excess spread technique uses option pricing in the determination of the true spread between the earnings power of assets and the cost of the liabilities. The excess spread can be measured at the time of pricing and throughout the life of the policy to provide an ongoing report card on the economic health of the product. The excess spread technique can also be used to measure the impact on expected profitability and risk of various external variables and different product management strategies.

The SPDA is one of the more complex nonparticipating insurance products from a modelling and analysis point of view. The same methods discussed here for the SPDA can also be used for pricing, risk and experience analysis for other nonparticipating products.

End Notes

1. Other publications available from the author at his Yearbook address include: *Excess Spread: A Profitability Measure for Insurance Products,* a look at the same technique applied to the various risks of a single premium immediate annuity, and *Measuring and Managing Cash Flow Antiselection Risk in Window GICs.*