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Kim B. Staking; David F. Babbel

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Kim B. Staking
David F. Babbel

In the preceding comment on our 1995 JRI article, Barney has done a commendable job in pointing out a flaw in the way surplus duration is sometimes measured. This flaw can arise when the spread between assets and liabilities is not correctly incorporated in the analysis, leading to a bias in the surplus duration estimates and limiting the implications of a study which relies on those biased estimates. The issues raised in the comment are valid and need to be addressed in a study that purports to measure surplus duration and link it to market value, and we appreciate the careful attention the author has given to our study.

It turns out that our study did not contain the flaw leading to the biased measures that the author suspected. However, we feel that he has performed a valuable service, because the misleading manner in which our article was written could lead others to suspect a similar bias. Space limitations caused us to reduce what was a 19-page detailed discussion of methodology to two sentences, one of which was misleading.¹ Therefore, we welcome this opportunity to clarify how the estimates of surplus duration were calculated. We will forbear from giving a 19-page explanation here, but will go beyond the single sentence contained in our 1995 article.

The first clarification we need to make is that we did not employ Macaulay duration measures. Rather, we estimated “effective duration” measures.² Our procedure for estimating asset portfolio durations involved five steps. The first step was to map the timing of portfolio cash flows. Second, we created a synthetic Treasury security with the same cash flow pattern. Third, a modified duration measure for this synthetic Treasury security was computed using the Treasury spot rates of interest (zero-coupon curve) prevailing at the end of each year in question. Fourth, this duration measure was then adjusted for call features using a matrix

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¹ The misleading sentence was: “Simple Macaulay duration measures are adequate for our purposes, given the limitations of our data set.” The other sentence was: “These calculations are then adjusted to account for differences in the relative volatilities of government, corporate, and municipal bond yields” (p. 706). The full discussion of our methodology is contained in Staking (1989, pp. 61–79).

² Effective duration measures take into account basis risk and the behavior of interest-sensitive cash flows, such as those associated with call options and prepayment behavior.

provided by Goldman Sachs for adjusting the durations of noncallable bonds to reflect call provisions. Fifth, the modified durations adjusted for call features were then further adjusted to account for the basis risk stemming from default risk and tax status, as reflected in the lower relative volatility of corporate and municipal bond yields to Treasury yields. A regression approach was used to estimate these relative volatilities.³ Thus, we wind up with estimates of effective duration of assets, where the reference rates of interest are Treasury rates.

In computing liability durations, we again followed the same five-step procedure described above, to the extent that the steps were applicable. We began by projecting the liability cash flows based on the modified Taylor Separation Method described in the appendix to our study. Next, we created a synthetic Treasury security with the same cash flow pattern. Third, we computed its modified duration, based on the prevailing Treasury spot rate term structure. Although substantial uncertainty was associated with the projected liability cash flows, we were unable to find convincing evidence that these cash flows were systematically related to nominal interest rate levels, so we did not need to adjust their values or the sensitivity of their values to reflect interest-sensitive cash flows.⁴ Accordingly, no further adjustments to the liability duration measures were deemed necessary.

These effective duration measures were then weighted using our best approximation of market values for assets and liabilities. All duration measures of assets and liabilities were calibrated based on the same reference rates of interest. Therefore, the bias suspected by Barney simply was not there. Indeed, estimates based on Barney's proposal, with a straightforward adjustment for the spread between assets and liabilities, treat the risky cash flows associated with assets and liabilities as if they were "risk free" in the duration calculation. This may induce an additional bias into the calculations.

As a further check on the impact of surplus duration on market value, we also performed a more direct test, as alluded to in footnote 22 of our study.⁵ In this instance, we estimated the surplus duration of insurers directly by regressing the total rates of return from each insurer's common stock against a measure of movement in the term structure of interest.

Because the rates of return on insurers' common stock were observed at monthly intervals, we could not simply regress them against changes in the yield curve to get a measure of duration. Instead, we used monthly total rates of return on zero coupon bonds with maturities of one, three, five, seven, ten, fifteen, and

³ The methodology used was actually a precursor to a more refined measure developed by Babbel, Merrill, and Panning (1997), but a version of it is described more fully in the beginning of their article. We believe our study (Babbel and Staking, 1989) to be the first to measure surplus duration using estimates of effective duration, which is now *de rigeur* in financial studies.

⁴ See Choi (1992) and Babbel and Merrill (1996). We did note some inflation rate sensitivity, but, during the period of study, we were unable to find appreciable sensitivity to nominal rates of interest, perhaps because of the pattern of decreasing inflation was offset somewhat by the increasing real rates that transpired during the period.

⁵ Again, space limitations required us to summarize 36 pages of detailed methodological discussion into a four-sentence footnote. The relevant pages covering this portion of the study are contained in Staking (1989, pp. 61–70, 77–79, 86–91, 106–108, and 112–125).

twenty years. This formulation is better suited for the regression-based calculation of duration than the usual method of using change in zero coupon bond yields, because it takes into account the time dimension of returns on the zero coupon bond from one month to the next. Since stock returns are calculated as monthly total rates of return, it is appropriate to use holding period total rates of return on the zero coupon bonds so that both sides of the regression equation are measured on a consistent basis and incorporate a similar time dimension.

Each zero coupon bond holding period return was next weighted inversely by its duration to create a composite measure of term structure movement. Because the volatility of the holding period rate of return on zero coupon bonds is approximately proportional to the term of the bonds, this adjustment was necessary to capture the movement along the entire term structure, while creating a series of returns with approximately similar variance. A composite return formed by equally weighing the duration-adjusted holding period returns will therefore be roughly weighted according to the relative volatility of each series.

To obtain an unbiased measure of surplus duration, we first controlled for stock market and industry-specific effects. This was accomplished by orthogonalizing the market and industry variables to the rates of return on the time weighted index of zero coupon bonds. Our surplus duration measures were then obtained by regressing total rates of return on each insurer's common stock against the composite return on zero coupon bonds, as well as the stock market return residuals (obtained by regressing the stock market returns against the zero coupon composite returns) and the insurance industry residuals (obtained by regressing the industry returns against the zero coupon composite returns and the stock market residual returns).

Results for the relation between the direct regression-based measure of surplus duration and insurer market value were similar to those based on the analytic measure of surplus duration, which was the main focus of our 1995 article. However, these results are interesting in that they avoid the potential problem pointed out by Barney. Because they are based on a directly observed empirical surplus duration measure, and not an indirectly derived measure, they are not subject to potential problems if a positive spread exists between assets and liabilities. Although that problem was avoided, the use of regression-based direct measures of surplus duration introduced other problems. Because some of the insurance companies in our sample had thinly traded securities, we were relegated to monthly observation intervals, and the surplus duration measures were estimated with imprecision and exhibited instability. These limitations reduced the explanatory power of our tests for the existence of a market reward for interest rate exposure management.⁶

Below we include the regression results and figures from the full study, where the regression-based direct measure of surplus duration was used. The saddle shape shown in Figure 1 is very similar to that which appeared in our 1995 article (shown here as Figure 2), which was obtained from the indirectly derived

⁶ The explanatory power of our tests was tripled, and the statistical significance of the duration variables was increased, when we used a different intercept term for each year.

analytic duration measures. We see this as additional evidence that the potential bias suspected by Barney was avoided through our conversion of modified Macaulay duration measures to effective duration measures using the same reference rates of interest.

$$Q = 1.15 + 0.361L - 0.030L^2 - 0.116D + 0.0035D^2$$

(0.477) (0.175) (0.014) (0.061) (0.0029)

(Standard errors shown in parentheses) RSQ: 0.054 F: 2.412 Prob > F: 0.051

- Q = Tobin's Q-ratio,
- L = leverage, measured as market value of assets divided by present value of liabilities, and
- D = surplus duration, based on regression estimates.

Figure 1
Market-to-Liquidation Value Ratio as a Function of Leverage
and Regression-Based Surplus Duration Measures

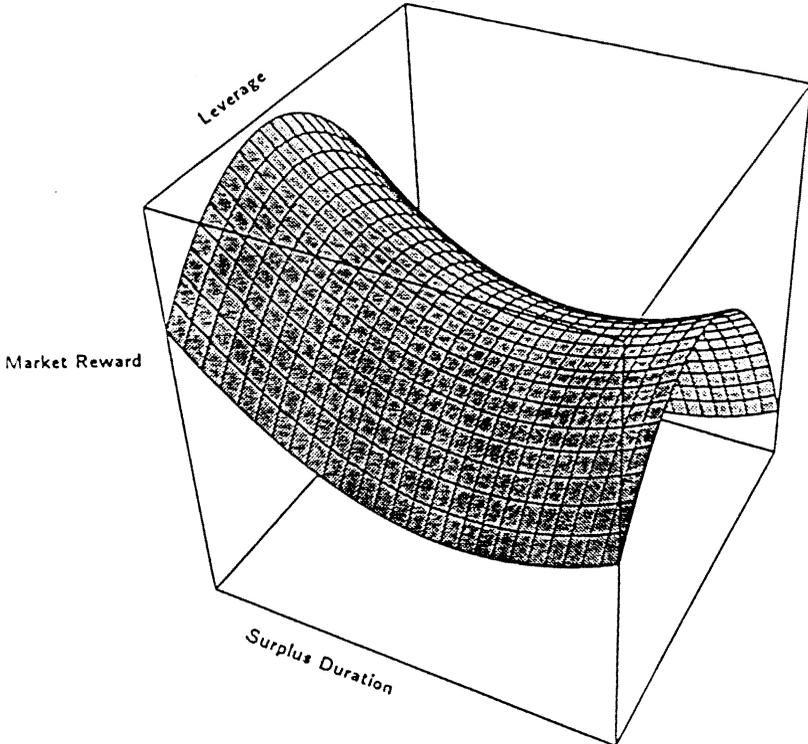
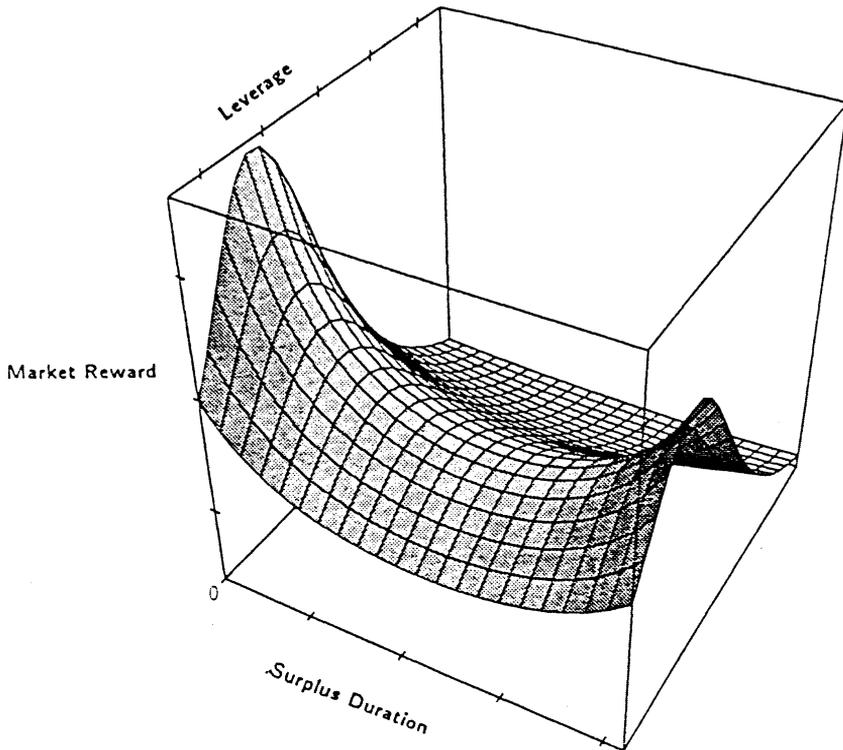


Figure 2
Market-to-Liquidation Value Ratio as a Function of Leverage
and Analytic Surplus Duration Measures



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