A NEW METHOD OF EXCESS RETURNS COMPUTATION; INDEX CONVERSION PROBABLE IN 2001

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Bond investors, especially active "relative-value optimizers," gain insight and gauge the efficacy of their portfolio practices by measuring the performance of spread-product asset classes relative to the Treasury asset class. This practice, which can be conducted in any currency with both spread products and government-issued treasury debt, requires the calculation of "excess returns" of spread securities over those of "equivalent" Treasury securities.

The notion of excess return has a long history. Intuitively, and initially through the simple observation of nominal return differentials, asset managers expect performance compensation for holding risky assets. For an individual security, a portfolio, or an entire asset class, excess returns offer a purer measure of this compensation than nominal returns. But many different excess-return calculation methodologies exist. These differences mainly reflect various mechanisms for defining an equivalent Treasury position.

The simplest technique compares a spread-sector bond's return to the nearest Treasury on-the-run. More precise methods require that the equivalent Treasury position match the duration of the spread security. The duration-bucket approach, introduced in 1995 and currently used by Lehman indices, calculates an equivalent Treasury return for each duration neighborhood. It is based on the average returns on Treasuries and spread sectors partitioned into semi-annual duration cells.

A security's duration does not fully reflect its yield curve exposure, particularly for securities with embedded optionality, such as callable bonds or MBS. A more precise method is to characterize fully each security's exposure along the curve by a set of key rate durations (KRD). Then its return can be compared with that of an all-Treasury portfolio with the same KRD profile. We are currently preparing an upgrade to our excess return calculations for all subcomponents of the U.S. Aggregate Index that will use this new methodology based on key rate durations.

Below, we describe how KRD are calculated and used to construct equivalent Treasury positions and to compute excess returns. The results of the new KRD-based method are then compared with the current duration-cell method. An intuitive approximation for excess return based on option-adjusted spread (OAS) helps compare the two methods. A detailed analysis of this approximation explains how to properly weight portfolio spreads and spread changes to allow portfolio-level quantities to be used in the excess return calculation.

Key Rate Durations and Excess Returns

The U.S. Treasury off-the-run yield curve is modeled daily at Lehman by fitting a smooth discount curve to the prices of U.S. Treasury securities. In addition, a term structure of volatility is fitted to a selected set of caps and swaptions. These fitted curves serve as the basis for our OAS models: a lognormal tree model for government and corporate securities and a Monte Carlo simulation model for MBS. In both models, sensitivities to changes in interest rates are measured by shocking the yield curve by a fixed amount, keeping volatility constant, and repricing each security at a constant OAS. This mechanism is currently used to calculate option-adjusted durations as sensitivities to a parallel shift in the Treasury par curve.

Key rate durations are sensitivities to the movement of specific parts of the par yield curve. We have selected six key points along the curve: 0.5, 2, 5, 10, 20, and 30 years to maturity. The movements of the par yields at these six points are assumed to capture the overall movement of the yield curve. Sensitivities of a bond to these six yields summarize its exposure to yield curve movements. To compute these sensitivities, the yield curve is perturbed by applying a change in the par yield curve around each of these points one at a time, and the bond is re-priced at a constant OAS. The sum of the six key rate durations is approximately equal to the option-adjusted duration. The distribution of the bond's duration among the six KRD gives a more detailed view of how it will respond to different types of yield curve movements.

To calculate excess returns using KRD, we proceed as follows. At the start of each month, we construct a set of six hypothetical par-coupon Treasuries corresponding exactly to the maturities of the six KRD. Each of these bonds is priced exactly off the curve (at zero OAS). To this, a riskless one-month cash security is added. A combination of these seven securities can be used to match the market value and KRD profile of any security as of the beginning of the month. This combination constitutes the equivalent Treasury position to which the security's return is compared. At the end of the month, each of the hypothetical securities is repriced at zero OAS off the end-of-month Treasury curve, and its total return for the month is calculated. An excess return for the security is then calculated as the difference between its total return and that of the equivalent Treasury position.

Figure 4 compares the excess returns computed for various Lehman indices in September 2000 using the new KRD-based method and the current duration-cell method. For the Gov/Credit index, the two models produce similar results. Sectors with more callable

Figure 4. **Excess Returns for Selected Components of the U.S. Aggregate Index by KRD-Based and Duration Cell Methods,** September 2000, %

Index	KRD-Based	Duration Cell-Based
Agency	0.54	0.48
Intermediate Agencies	0.42	0.35
Long Agencies	1.15	1.14
Callable Agencies	0.36	0.26
Credit	0.25	0.19
Intermediate Credit	0.26	0.20
Long Credit	0.23	0.17
Callable Credit	0.12	0.02
Gov/Credit	0.18	0.15
Long Utilities	-0.08	-0.22
MBS	0.44	0.12

bonds show greater differences between the two methods. The largest discrepancy between the two models is for the MBS Index, for which the KRD-based excess return is 44 bp, as opposed to the 12 bp produced by the duration-cell approach. (Our mortgage research group pioneered the KRD-based methodology precisely because of the problems inherent in applying the duration cell approach to MBS.)

Figure 5 compares historical excess returns obtained by the two models for the U.S. Credit Index over the last nine months. For the most part, the two models produce similar results. In three months out of nine, however, the differences between the models were 9 bp or greater.

Approximating Excess Returns from OAS

As discussed above, no excess return methodology has been standardized in our industry. To help evaluate excess returns produced by the two models described, we calculated excess returns on the Credit Index using a third method. This is a simple intuitive approximation based on the sources of excess return for spread product. Securities considered more risky than Treasuries "usually" earn a spread over Treasury yields; when a spread remains unchanged, the excess return should be approximately equal to the spread itself. The risk of such securities is realized when spreads do change. In this case, the additional (positive or negative) excess return is given by the "change in spread" times the "spread duration."

Let ER_i denote the excess return of bond i ; s_i , its option-adjusted spread (OAS); Δs_i, the monthly change in OAS; and D_i , its spread duration. Our simple first-order approximation for monthly excess return is given by

$$ER_i \approx \frac{s_i}{12} - D_i \Delta s_i \qquad (1)$$

(The charming simplicity of this approximation might lead one to ask why this should not be adopted as our official definition of excess return. Yet, this simple model does not cover all possible sources of return differences between Treasuries and spread product. For example, callable bonds may experience excess returns due to volatility changes, even with unchanged OAS. Returns on mortgage-backed securities are affected by prepayment surprises and volatility changes in addition to changes in spread. Therefore, it is important to retain a model that works in return space, by subtracting an equivalent Treasury return from each security's total return.)

Figure 5. **Monthly Excess Returns for the Lehman Brothers Credit Index: Comparison of the Two Methods, %**

	12/99	1/00	2/00	3/00	4/00	5/00	6/00	7/00	8/00
Duration-Cell Exc. Ret.	0.27	-0.43	-0.50	-1.34	-0.49	-0.58	0.69	0.28	-0.22
KRD-Based Exc. Ret.	0.14	-0.44	-0.59	-1.31	-0.46	-0.60	0.70	0.19	-0.21
Difference	0.13	0.01	0.09	-0.03	-0.03	0.02	-0.01	0.09	-0.01

While this OAS-based approximation of excess return may not be rigorously correct for volatility-sensitive instruments, we feel that it gives intuitive results for a largely non-callable index such as the U.S. Credit. As shown in Figure 6, OAS-approximated excess returns for the Credit Index agree quite closely with the new KRD-based approach. In particular, in the three months in which the KRD method and the duration-cell method disagree (December, February, and July) the OAS-based approximation is much closer to the KRD-based numbers. This supports our opinion that the proposed new KRD method is superior to the earlier, duration-bucket approach currently in use by our index team and non-MBS strategists.

Averaging Portfolio Spreads and Spread Changes

In the application of the OAS-based estimate to portfolio or index excess returns, one detail merits a closer look. It is important to pay attention to the weighting mechanism used to compute portfolio averages. We show that while the spread levels should be weighted by market value, the changes in spreads should be weighted by dollar duration (the product of market value and spread duration). A failure to do so can lead to inaccuracy when the market experiences changes in the term structure of spreads.

For a portfolio, let w_i represent the percentage of portfolio market value in security i. The portfolio excess return (for one month) is then the weighted sum of component securities' returns:

(2) $$ER_P = \sum_i w_i ER_i \approx \frac{\sum_i w_i s_i}{12} - \sum_i w_i D_i \Delta s_i$$

Let us look at how this calculation can be expressed in terms of portfolio-level quantities. We define the following portfolio averages for spread duration, spread, and spread change:

(3) $$\begin{aligned} D_P^{MW} &= \sum_i w_i D_i \\ s_P^{MW} &= \sum_i w_i s_i \\ \Delta s_P^{DDW} &= \frac{\sum_i w_i D_i \Delta s_i}{\sum_i w_i D_i} \end{aligned}$$

Figure 6. **Monthly Excess Returns for the Lehman Brothers Credit Index: Comparison with OAS-Based Approximation**

	12/99	**1/00**	**2/00**	**3/00**	**4/00**	**5/00**	**6/00**	**7/00**	**8/00**
Duration-Cell Exc. Ret.	0.27	-0.43	-0.50	-1.34	-0.49	-0.58	0.69	0.28	-0.22
KRD-Based Exc. Ret.	0.14	-0.44	-0.59	-1.31	-0.46	-0.60	0.70	0.19	-0.21
OAS-Based Estimate	0.14	-0.42	-0.56	-1.33	-0.53	-0.62	0.70	0.18	-0.20

where the superscript MW refers to a market-weighted portfolio average and the superscript DDW denotes a dollar duration-weighted average. The quantity D_P^{MW} is the market-weighted average portfolio spread duration; s_P^{MW} is the market-weighted average portfolio OAS; and Δs_P^{DDW} is the dollar duration-weighted average portfolio OAS change.

We can see that the approximation for portfolio excess return given in equation (2) can be rewritten as

$$ER_P \approx \frac{s_P^{MW}}{12} - D_P^{MW} \Delta s_P^{DDW} \quad (4)$$

The first term of equation (2) is given by the market-weighted spread. In the second term, the duration cancels out the denominator of the duration-weighted spread, leaving an expression identical to that found in equation (2).

This weighting scheme is in accord with our intuitive understanding. The first component corresponds to the return that will be earned by each security if its spread remain unchanged. This spread should be weighted by market value, as are returns. The second term represents the return impact of spread changes. Spread changes in longer securities will have a greater effect and should be given greater weights.

Is this overly complex for a "back-of-the-envelope" calculation like this one? It would certainly be simpler just to use all market-weighted quantities in equation (4). One can wonder how much of a difference it could make. The answer is clear from Figure 7, which compares the results of our approximation using both market and dollar-duration weights with the excess returns from the KRD-based methodology (considered to be superior to the duration cell one). The dollar-duration weighted estimate agrees quite well with the KRD-based approach. The use of market-weighted spread change leads to inaccuracies of 14 bp or more in either direction in five out of the nine months shown.

Figure 7. **OAS-Based Approximation of Excess Returns for the Lehman Brothers Credit Index: Comparing Market- and Dollar-Duration-Weighting of Spread Changes**

	12/99	1/00	2/00	3/00	4/00	5/00	6/00	7/00	8/00
KRD-Based Exc. Ret.	0.14	-0.44	-0.59	-1.31	-0.46	-0.60	0.70	0.19	-0.21
OAS-Based Est. (DDW)	0.14	-0.42	-0.56	-1.33	-0.53	-0.62	0.70	0.18	-0.20
OAS-Based Est. (MW)	0.16	-0.26	-0.32	-1.24	-0.78	-0.43	0.56	0.20	-0.10
Error (DDW)	0.00	0.02	0.03	-0.02	-0.07	-0.02	0.00	-0.01	0.01
Error (MW)	0.02	0.18	0.27	0.07	-0.32	0.17	-0.14	0.01	0.11

Why is the dollar duration-weighted approximation consistently accurate while the market-weighted method results vary? What is the difference between July 2000, when the market-weighted approximation was as good as the dollar duration-weighted one, and April 2000, when the market-weighted approximation was significantly off? Figure 8 provides some clues.

In July 2000, spread movements were consistently small across the yield curve. In March, there was a significant widening, but it was relatively consistent across the curve. On the other hand, the April widening was uneven, with its level varying greatly depending upon duration bucket. Whenever there are systematic changes in the shape of the spread curve, a market-weighted change in spreads will give a distorted estimate of the effect on returns.

Conclusion

The use of key rate durations to calculate excess returns should result in more accurate results, particularly for volatility-sensitive securities like callable bonds and MBS.

A simple approximation of excess return based on OAS and changes in OAS supports the proposed KRD-based methodology. When using this approximation, the portfolio-level spread change should be calculated as a dollar-duration-weighted average of the security-level spread changes.

Accordingly, we are seriously contemplating a switch by early 2001 in the methodology used to report excess returns for our indices. This may affect the relative performance of some spread-sector asset classes, especially during intervals of extreme yield curve and spread perturbations. In turn, this may influence asset allocation decision-making by active bond managers.

As always, we encourage all feedback from our many index-using readers.

Figure 8. **OAS Changes Per Duration Bucket**