Lev Dynkin 212-526-6302
ldynkin@lehman.com
Jay Hyman 972-3-623-8745
jhyman@lehman.com
Vadim Konstantinovsky, CFA 212-526-8290
vkonstan@lehman.com

EMPIRICAL DURATION OF HIGH-YIELD CREDIT

Many portfolio managers with investment-grade benchmarks are allowed out-of-benchmark ("core-plus") allocations to high-yield debt. As with any other asset class, they need to understand the effect such allocations have on the overall portfolio duration.

Portfolio analytics will, of course, dutifully turn out duration numbers for high-yield bonds, based, as they are for all other bonds, on their projected cash flows. Yet it is widely acknowledged that the interest rate sensitivity of high-yield securities is not necessarily what their stated cash flows imply; many claim that high-yield debt exhibits rather equity-like behavior.

We have seen a wide range of opinion on this issue among portfolio managers. At one extreme, there are those who account for the full analytical duration of the high-yield component. At the other extreme are the managers who ignore the duration contribution of high yield entirely and base their assumed exposure to interest rates on investment-grade instruments alone. The majority in between usually have some heuristic rule of thumb—for example, to consider 25% of the analytical duration for high-yield bonds.

Not infrequently, the attitude is that the duration assigned to high-yield bonds is not particularly important because the interest rate risk of a high-yield investment pales in comparison to the credit and default risks involved. When one is prepared to accept such major risks, should one worry about a bit more or a bit less interest rate exposure?

In fact, uncertainty about the interest rate sensitivity of high-yield bonds can severely affect the ability of portfolio managers to express their views on rates accurately. Assume, for example, that a portfolio and its benchmark both have duration of 5 and that the manager shifts 10% of the portfolio into high yield, also with (analytical) duration of 5. Depending on one's opinion, the "true" duration of the portfolio is anywhere between 4.5 and 5.0—a tremendous range for many managers used to tweaking duration in much smaller increments when expressing their views on rates. If the portfolio target duration is 4.80 and the manager is prepared to adjust the Treasury component of the portfolio to hit this target, does he need to add duration or subtract it?

In this article, we use historical index data to find the empirical duration of high-yield (and investment-grade) bonds in different credit rating categories, using several different approaches.

First, we regress daily price returns of whole-letter-grade components of the Lehman IG and HY Credit indices against daily changes in the 10-year U.S. Treasury yield. The (negative of the) regression coefficients can be interpreted as empirical durations, i.e., the return realized per unit of yield change. These are plotted in Figure 1a alongside the average analytical durations (OAD) for each index over the same period: August 1998-September 2004. We see that in higher qualities, the empirical durations are almost identical to OAD; for the Baa rating, the gap increases somewhat; and for high yield the empirical durations plummet to near zero.

The R-squared of the regressions (Figure 1b) confirm the common knowledge: changes in interest rates explain most of what happens to investment-grade debt and very little of what happens to high yield. Nevertheless, a distinction can be drawn between the Ba category, where interest rates explain 9.4% of return variance, and the two lower-rated categories for which the explanatory power is zero.

As far as the duration levels themselves, we find that for the Ba rating category the empirical duration is 1.27, or 24.4% of the analytical OAD of 5.21. For B-rated debt, the empirical duration is effectively zero, and for securities rated Caa and below duration actually becomes negative, indicating that this asset class tends to have positive returns when interest rates rise.

One possible explanation for the pattern in Figure 1 is the negative correlation generally observed between interest rates and credit spreads. This is what makes the total return volatility of investment-grade credit indices lower than that of Treasuries; here, it shows itself as a decrease in empirical duration as the exposure to credit spread risk grows. The lower the credit quality, the more pronounced this effect becomes. In the extreme, the exposure to credit spread becomes high enough to create negative durations.

Figure 1a. **Empirical 10-Year Duration: versus OAD**
Daily Observations, 8/98 - 9/04

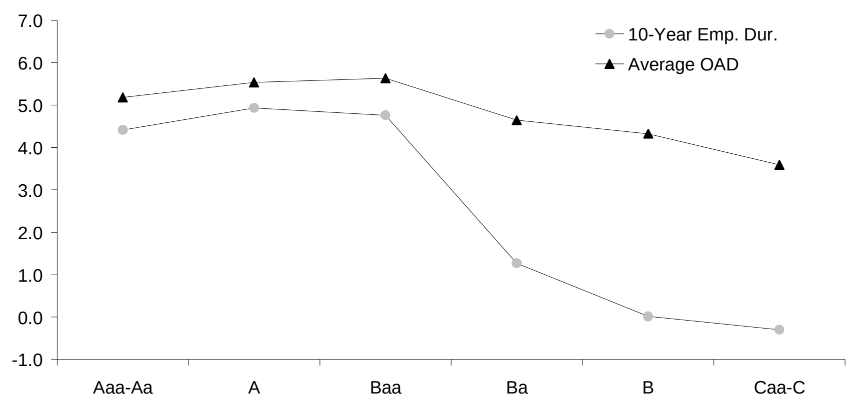
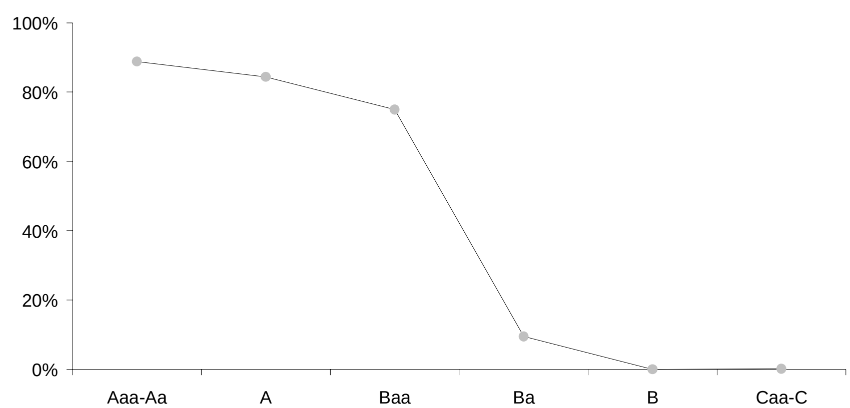


Figure 1b. **Empirical 10-year Duration: R-Squared**
Daily Observations, August 1998-September 2004



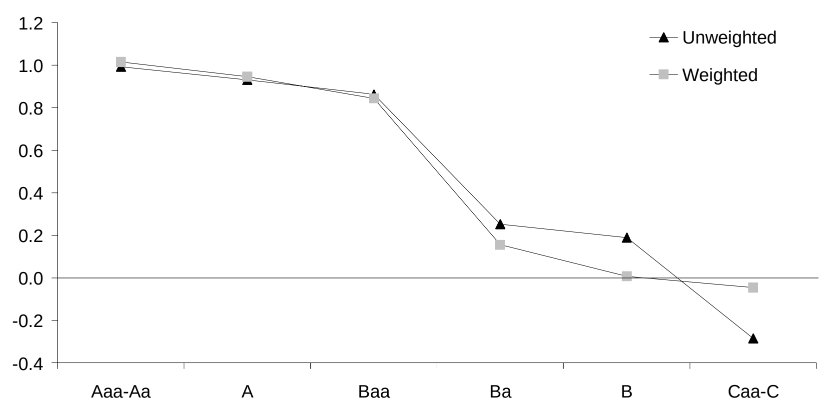
To corroborate these results, we turned to our Global Risk Model. For each of our letter-grade credit indices, we performed the following experiment. We calculated the key rate durations (KRD) of the index (the full analytical values) and then constructed an all-Treasury portfolio with the same KRD profile. We then used the risk model to analyze the two against each other, using the all-Treasury portfolio as the benchmark, and the credit index as the portfolio. Among other things, the risk model calculates beta of the portfolio relative to the index, defined as the ratio of the covariance of portfolio and benchmark returns to the benchmark return variance. For a unit of the benchmark return, beta gives the expected portfolio return. Beta can also be viewed as a hedge ratio. In this particular case, where the benchmark represents pure term structure risk, a beta of one means that the expected response of the portfolio to a change in rates is exactly in line with what is implied by its KRD profile. A beta less than one means that the KRDs taken alone overstate the exposure to term structure risk and that once the model takes into account the correlation between term structure factors and all other risk factors, the effective sensitivity to changes in rates is just a fraction of what is implied by the KRDs alone.

Figure 2 shows the risk model betas obtained for different credit ratings. Consistent with Figure 1, we see a beta of 1 for credits rated Aa and better, and a small decrease from this value as we move to the A and Baa ratings. A sudden drop occurs as we cross into high yield, with the betas for Ba near 0.2 and those for lower-rated credits near zero.

Two different sets of risk model results are shown in Figure 2, reflecting two different methods of calibrating the model covariance matrix from historical data. The "unweighted" mode uses all historical data available and is, thus, based on about 15 years worth of monthly bond market history. The "weighted" mode uses exponential time decay with a half-life of one year to ensure a much stronger influence by the most recent historical data.

The close agreement between Figure 1 and the two results in Figure 2 is quite remarkable, especially considering the different datasets that were used in the analysis. The regressions of Figure 1 used six years of daily data, while the two risk model results of Figure 2 are based on monthly data histories that are either longer (in the unweighted case) or

Figure 2. **Risk Model Betas: Credit Indices versus KRD-Matched Treasuries**
As of September 30, 2004



shorter (weighted) than the daily dataset. The largest disagreement among the three results is in the lowest-rated portion of the High Yield Index. The longest data series points to a significant negative empirical duration for Caa and lower (beta of -0.29); the estimates based on more recent history indicate a beta closer to zero. Similarly, for B-rated credits, the long-term beta is 0.19, but the more recent estimate is closer to zero.

In the Ba rating category, the unweighted risk model results dovetail quite nicely with the daily regressions, with both showing the empirical duration of about 25% of the analytical duration. These results seem to justify certain popular practices. A rule of thumb to recognize 25% of analytical duration might indeed be called for when the high-yield investment consists largely of Ba-rated securities, but 0% might be more appropriate for lower-rated high-yield investments.

Just how much of an effect on portfolio performance might this have? Do these relatively modest duration adjustments matter at all, compared with the volatility of high-yield investments? We investigate by a historical simulation of a simple high-yield core-plus strategy. To a portfolio benchmarked against Lehman U.S. Gov/Credit Index, we add a 10% out-of-benchmark allocation to Ba Credit. To implement this, we shift assets out of the IG Credit portion of the portfolio. We then address the duration mismatch between the resulting portfolio and the Gov/Credit benchmark by adjusting the Treasury component (reweighting between its long and intermediate parts, above and below 10 years, respectively). This duration-hedging adjustment is carried out under several different assumptions of how much of the analytical duration of the Ba component should be counted in the portfolio duration.

Figure 3 shows the results of a historical simulation of these different hedging approaches from January 1996 through September 2004, using monthly rebalancing and monthly returns. We first looked at the standard deviation of strategy outperformance over time, or tracking error volatility (TEV). In this regard, the results were mixed. Relative to the 100% case, the hedging strategies that recognize only a part of the high-yield duration contribution (and hence add duration in Treasuries to prevent an unintended duration underweight) do show a decrease in TEV. Ignoring the duration of Ba credit entirely causes duration over-hedge and leads to an even higher TEV (the 0% case). However, the decreases in TEV in the partial-hedging cases are relatively small compared to the total amount of risk, from 14.8 bp/month down to a minimum of 13.8. Also, if minimizing TEV is the goal, the best hedge ratio seems to be 50%, and not 25% as indicated by our empirical studies.

Figure 3. **Effect of Assumed Duration Hedge Ratio, versus Gov/Credit Index**
10% Core-Plus Position in Ba Credit, January 1996-September 2004

Assumed Duration Contribution of High Yield (% of OAD)	100%	50%	25%	0%
Realized Tracking Error Volatility, bp/Month	14.8	13.8	14.2	15.1
Correlation of Outperformance with Treasury Index Return	-0.53	-0.20	-0.01	0.16

We should bear in mind, though, that the main goal of the strategy is to express a view on the Ba asset class while remaining neutral on interest rates. To test how well this was accomplished, we measured the correlation of the strategy's outperformance with the total return of the U.S. Treasury Index. Here, once again, we see that this is best accomplished with the 25% hedging rule. When the full duration of the Ba component is included in our portfolio duration, the outperformance series has a correlation of -0.53 with the Treasury index, a clear indication of a duration underweight (whenever the Treasury index does well, the portfolio underperforms.) When the Treasury hedge is increased because 0% contribution of the Ba duration is assumed, we cross over to a positive correlation, indicating a duration overweight. The crossover point at which the correlation becomes zero is at a beta of almost exactly 25%.

If interest rates do not drive high-yield returns, what does? It is widely perceived that high-yield returns follow the equity market, so our next step was to regress the monthly price returns of the letter-grade credit indices on the returns of broad equity market indices. The results were fairly disappointing. As shown in Figure 4b, the R-squared for

Figure 4a. **Credit Indices versus Equity: Regression Betas**
Monthly Observations, November 2000-September 2004

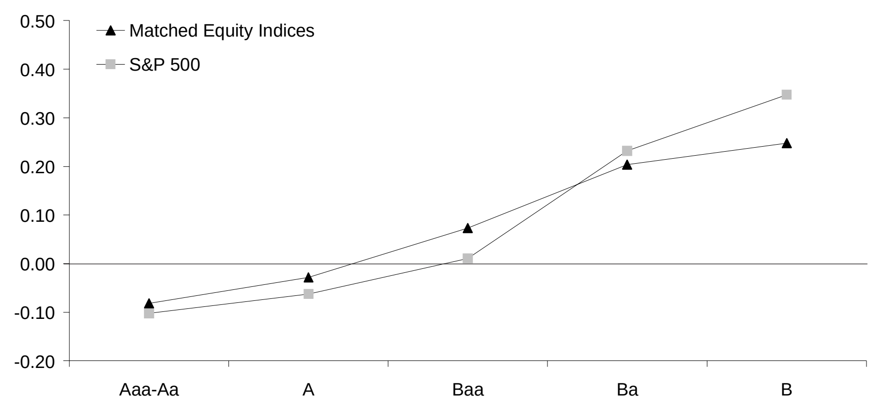
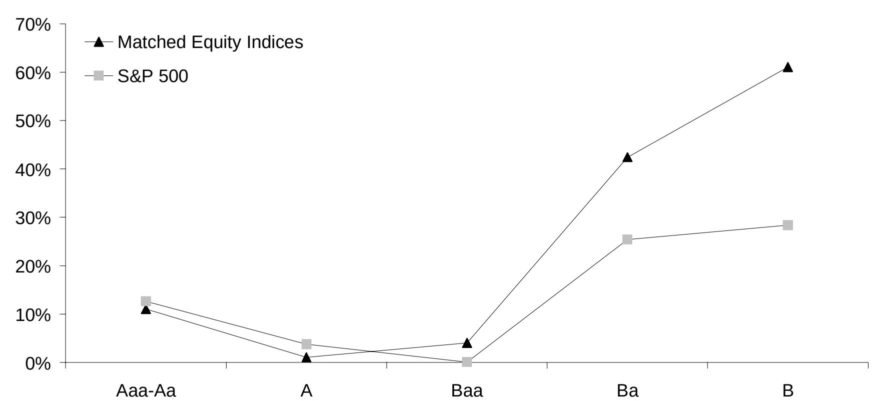


Figure 4b. **Credit Indices versus Equity: Regression R-Squared**
Monthly Observations, November 2000-September 2004



the S&P 500 Index did not exceed 30% for bonds of any credit rating.[1] We then replaced the broad market index by customized equity indices matched to each bond index. These "matched-equity" indices consist only of the equity of the issuers in the particular bond index, with weights determined by the issuer market value weights within the bond index. Regressions of letter-grade credit indices against their matched-equity indices showed much higher explanatory power for the high-yield returns, with R-squared as high as 61% for B-rated credit. The important message here is that the assumption that high-yield returns strongly follow equity returns is only true at the level of a single firm. While a particular high-yield bond might be best hedged by the equity of the issuing firm,[2] equity market as a whole does not explain high-yield returns.

We have attempted to measure the empirical duration of high-yield bonds via simple empirical methods. We have seen that their empirical duration is much lower than their analytical duration, and surmised that this is due to the negative correlation between Treasury yields and credit spreads. Partly to test this theory, and partly to separate the direct effect of interest rate moves from the indirect effect of other correlated factors, we carried out one more set of regressions to explain monthly high-yield returns. This time, we used three variables: the matched-equity indices discussed above, the 10-year Treasury yield change, and the monthly change in the OAS of the U.S. Investment-Grade Credit Index.

The results of these regressions are shown in Figure 5. We found them interesting in several ways. First, this combination of factors does a good job of explaining index returns across the credit spectrum, with high R-squared down through high yield. As expected, the key explanatory factor (the one with the high t-statistics) for investment-grade credit is the 10-year yield change. We were particularly intrigued by the fact that all three factors were statistically significant (t-statistics with absolute value greater than 2) from Baa through B.

[1] Figure 4 shows the results for the S&P 500 index over a relatively short period. We repeated this regression over a much longer period (January 1989-September 2004), as well as for two broader equity indices—the Russell 2000 and the Wilshire 5000. None of these other regressions achieved an R-squared above 30%.

[2] An extensive treatment of bond-equity hedging may be found in *Hedging Debt with Equity*, Lehman Brothers, November 2003.

Figure 5. **A Deeper Look: Results of a Multivariate Regression**
Monthly Observations, November 2000-September 2004

	Aaa-Aa	A	Baa	Ba	B	Caa-C
Coefficients						
Intercept	0.05	-0.06	-0.12	-0.26	-0.42	-0.69
Matched Equity	0.03	0.01	0.06	0.15	0.16	0.18
IG Credit OAS Change	-0.97	-4.58	-6.96	-8.91	-9.5	-11.47
10-Year Yield Change	-4.65	-5.19	-5.67	-2.92	-2.66	-1.79
R-Squared	97%	96%	96%	73%	71%	64%
T-Statistics						
Intercept	1.28	-1.32	-2.13	-1.46	-1.6	-1.47
Matched Equity	2.55	0.86	3.88	3.94	4.61	4.55
IG Credit OAS Change	-2.51	-8.77	-12.12	-5.13	-3.58	-2.44
10-Year Yield Change	-32.53	-31.52	-28.86	-4.71	-3.04	-1.13

The equity component is significant even at the Baa level (and somewhat improbably, for Aa), and the interest rate sensitivity remains significant down to the B level. When we looked at the single-variable regression against Treasury yields, we found little or no sensitivity for B-rated credits, due to the correlations with credit spreads and equities. When these other exposures are adequately hedged, the remaining return does retain an interest rate component—roughly equivalent to half of its analytical duration.

The regression coefficients for the OAS change variable confirm our earlier conclusions. As we go down the credit spectrum, the sensitivity to the spread factor continues to increase. In a sense, it seems as if high yield represents an amplified exposure to investment-grade credit spreads. This increased exposure, combined with the negative correlation of this factor with interest rates (-0.23 for July 1989-September 2004), causes the steep decrease in empirical duration seen in Figures 1 and 2.

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This brief study endeavors to shed light on a very practical issue of hedging interest rate exposure of high-yield investments. The sheer number of opinions on the subject that we've encountered, as well as the *ad-hoc* nature of many practices adopted by various managers, show that this is still very much an open question. Our empirical results corroborate one of the more prevalent practices: hedging a quarter of the high-yield duration. We derive additional confidence from the fact that different methods, applied over different time periods, seem to indicate the same "magical" number of 0.25. The necessary caveat, though, is that this hedge ratio applies only to the Ba part of the high yield market. Lower-quality investments, such as B and Caa, exhibit essentially no interest rate sensitivity and do not require additional hedging when added to investment-grade portfolios.

As with all empirical findings based on historical data, caution is in order. Empirical durations can vary significantly from one time period to another. The behavior of high yield in the coming year could be different from historical experience. For example, with the current spread on B-rated credit down to just over 300 bp, a substantial upward move in rates is likely to push its yield higher. If that happens, we may see durations significantly higher than they have been historically.

In the course of the study, we also obtained a deeper insight into *why* these lower-quality bonds seem to have zero duration. Additional regressions using equity returns, as well as the multivariate regression described just prior to this conclusion, convinced us that sensitivity of high-yield bond's cashflows to interest rates does not just disappear, or gets replaced somehow with sensitivity to equity market moves. The main reason behind the apparently non-existent duration is that credit spread sensitivity reaches a level where its magnitude is comparable to rates sensitivity. The negative correlation between the two (a well known phenomenon in itself) then produces duration that, depending on the time period and other factors, hovers around zero.

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