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EMPIRICAL DURATION OF EMERGING MARKET BONDS

Introduction

In two recent studies, we examined empirically the exposures of high yield securities to changes in Treasury yields.[1] A long-term historical analysis showed that BB securities have shown exposures equivalent to roughly one-fourth of their analytical duration, while those rated B and lower had essentially zero (or even negative) exposures. We then investigated the dependence of these hedge ratios on spread levels and found clear evidence that the hedge ratios increase as spreads tighten—so that in the current low-spread environment, the appropriate hedge ratio for BB may be closer to one-half of the analytical duration rather than one-fourth.

A logical extension of this work is to see to what extent these results carry over to emerging markets (EM), where spreads and spread volatilities can be even higher than in high yield. Many portfolio managers treat emerging market securities as having zero Treasury duration, which in general may be a reasonable approximation given the very small portion of EM returns that can be explained by changes in Treasury yields. In light of the relatively tight spreads at which the market has been trading recently, is this the best approach?

We find that emerging markets credit indeed exhibits time-varying interest rate sensitivity. In periods in which default risk is relatively low, as reflected by tight spreads, movements in the U.S. Treasury curve account for roughly 25% of the return variation of emerging markets credit, and the empirical hedge ratio is about 0.5. In contrast, in periods of extreme spread widening as a result of political crises and other events, we find no interest rate sensitivity, and the appropriate hedge ratio is zero.

We expect our results to be of interest primarily to managers of core-plus portfolios, who need to manage overall portfolio exposures to Treasury yields, including the effect of non-core investments such as high yield and emerging market bonds. However, even pure emerging market investors may want to note that Treasury yields play a more important role in this market than was the case in the past.

One caveat the reader should keep in mind is that emerging markets are extremely diverse and hard to describe by hard and fast rules. Market dynamics can be strongly influenced by political and economic events at the country-specific and regional levels. Furthermore, the mix of different types of bond structures (collateralized, various fixed/floating combinations, amortizing structures) can further complicate the analysis. We take a rather "broad brush" approach to the behavior of this market; more focused analysis could very likely give greater insight into the specific details of any local market.

Empirical Analysis

To examine the relation between empirical duration and spread level in emerging markets, we use daily data between January 2000 and April 2005 from the Lehman Brothers Emerging Markets Index. However, Brady bonds, which currently make up roughly 8.5% of the index, are excluded from the analysis since they are collateralized by U.S. Treasuries. As a result, the prices of Brady bonds are much more sensitive to changes in

[1] "Empirical Duration of Credit Securities: Dependence on Spread," *Global Relative Value*, Lehman Brothers, March 14, 2005, and "Empirical Duration of High Yield Credit," *Global Relative Value*, Lehman Brothers, November 8, 2004.

the U.S. yield curve than other EM bonds. We also exclude local issues and concentrate on the international issues in the USD-denominated Emerging Markets Index.

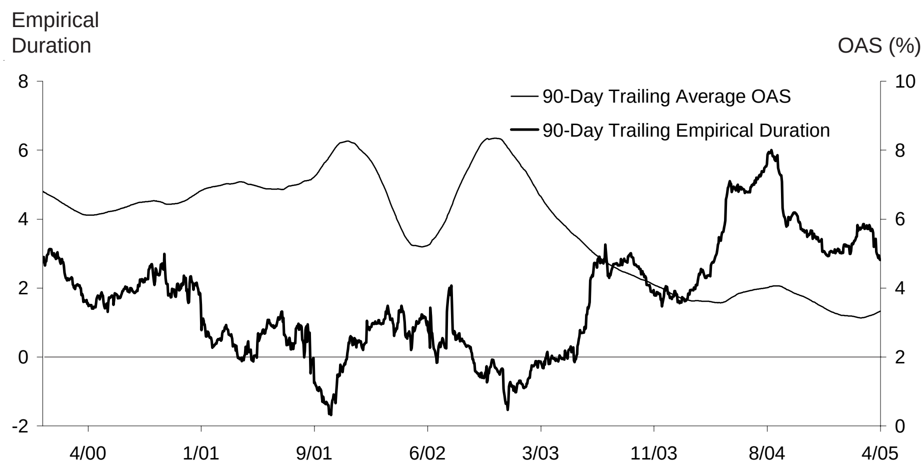
Figure 1 plots the average spread level for the EM Index between January 2000 and April 2005 alongside the 90-day trailing empirical duration during that period. The empirical duration figures are obtained by regressing the daily price returns of the index against the yield changes of the on-the-run 10-year Treasury.

As we have seen previously for high yield debt, two key observations are evident. First, the empirical duration varies greatly over time, ranging from a high of more than five years to a low of less than -1. Second, these variations can readily be seen to be negatively correlated with spread levels. In particular, rapid widening of spreads following events such as 9/11 or the political crisis in Brazil in 2002 is closely matched by low and even negative Treasury durations. In contrast, tighter spreads are accompanied by higher empirical durations.

Figure 2 shows the results of several regressions seeking to explain the index price returns in terms of Treasury yield changes. A first model is estimated using only the product of the 10-year Treasury yield change with the analytical duration. This model produces an estimate of a constant hedge ratio. In the second model, we add another variable that is equal to the product of the first variable with the level of spread. This term (denoted as "spread slope") controls for changes in the hedge ratio due to changes in the spread environment.

The first model, which reflects the long-run average hedge ratio for the index, yields an estimate of roughly 0.35. The two-variable refinement shows the hedge ratio as a linear function of spread, with a theoretical limit of 0.99 if spreads would go to zero and a decrease of 0.12 for every 100 bp of spread. We also partition the sample by spread level into three regimes: tight, neutral, and wide. Separate sets of regressions were carried out on each of the sub-samples. The narrower range of spreads within each of these regime-specific sub-samples made the spread

Figure 1. **Empirical Duration and Spread of the Lehman Brothers Emerging Markets Index (International Issues Only)**
Daily Observations, January 2000-April 2005



coefficient less important for the most part, so we focus on the single-variable results for these three regimes. Roughly speaking, these results show that the hedge ratios are close to 0.5 in the tight spread regime, 0.25 in the neutral regime, and 0 when spreads are wide.

Figure 3 compares the results obtained using the two-variable regression for the entire sample (the smooth linear dependence on spread) with those obtained by combining the one-variable results from the three distinct spread regimes. We find that the two approaches agree quite nicely.

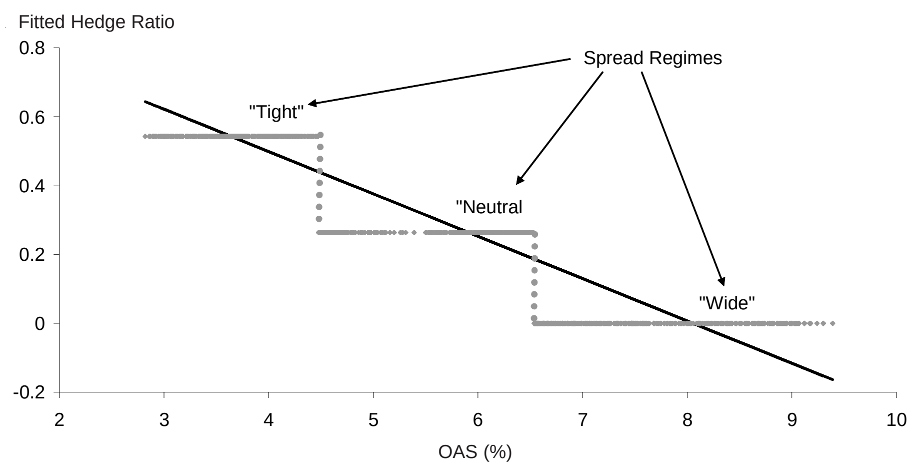
Figure 4 presents a comparison of two approaches for computing hedge ratios:

1) 90-day trailing empirical hedge ratio
2) Using the regression estimates from Figure 2 as a function of index spread level, as follows: Calculated hedge ratio = 0.99 – 0.12 * OAS

Figure 2. **Regression Estimates of Empirical Hedge Ratios**
Daily Data, January 2000-April 2005

	Full Sample	Spread Regime "Tight"	Spread Regime "Neutral"	Spread Regime "Wide"
Minimum OAS	2.82	2.82	4.48	6.54
Maximum OAS	9.39	4.47	6.53	9.39
Average Hedge Ratio	0.353	0.543	0.264	0.06
t-Stat	10.33	13.02	4.33	0.74
Adjusted R^2	7.43%	27.5%	4.0%	0.1%
Hedge Ratio (Limit)	0.991	0.515	1.237	1.267
t-Stat	9.44	1.35	2.75	1.54
Spread Slope Coefficient	-0.123	0.007	-0.178	-0.156
t-Stat	-6.42	0.07	-2.19	-1.47
Adjusted R^2	10.20%	27.7%	5.1%	0.6%

Figure 3. **Calculated Hedge Ratios, as a Function of Spread, Based on Estimates from Two-Variable Regressions on Entire Sample and Separate One-Variable Regressions by Spread Regime**
Daily Data, January 2000-April 2005



The plot demonstrates that the two approaches provide very different estimates at times, despite the fact that both control for the spread environment. The regression-based approach uses a much larger historical data sample, spanning different spread regimes, and uses the current spread to adjust the duration estimate. In the 90-day trailing estimate, adaptation to the current environment is accomplished by using only the most recent data; this makes its duration estimates very sensitive to extreme observations. As a result, while both approaches follow the same general trends, the regression-based estimates fluctuate much less wildly as the market moves.

The Emerging Markets Index comprises more than 20 countries with different macro-economic characteristics. For countries with close economic ties to the U.S., a change in the yield curve may contain important information about macroeconomic variables in addition to a change in the discount rate. Hence, it is likely that sensitivity to yield changes will vary across countries.

Figure 4. **Time Series of Calculated Hedge Ratios Using Different Approaches**
Daily Data, January 2000-April 2005

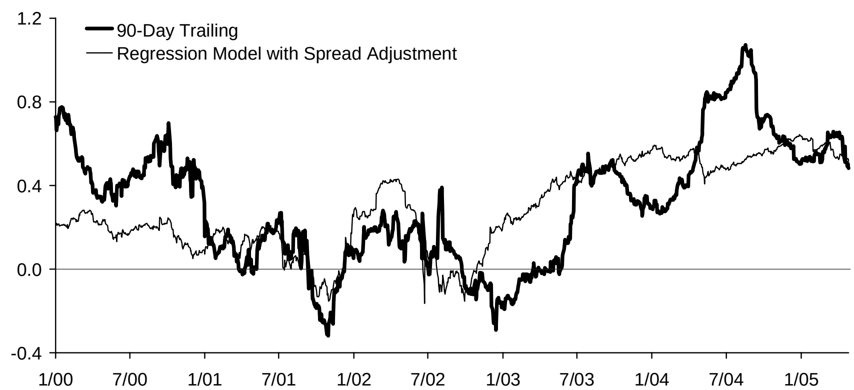
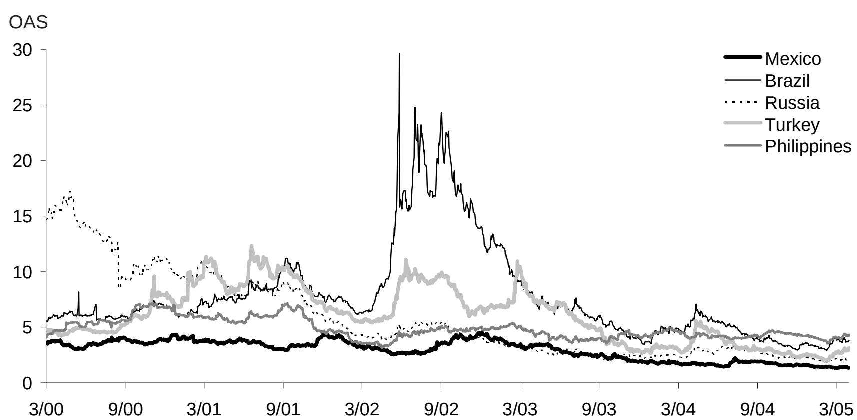


Figure 5. **Time Series of Spreads for Several EM Countries**
Daily Observations January 2000-April 2005; International Issues Only



To examine this issue we investigate the relation between spread and hedge ratio separately for five countries: Mexico, Brazil, Russia, Turkey, and the Philippines. These countries were selected because of their different geographical location, trade relationship with the U.S., and weight in the index (their combined weight in the index is currently almost 65% and was even larger before Mexico left the EM Index). In addition, as Figure 5 illustrates, they experienced different spread environments during the study period. For example, the spreads of Mexican and Russian bonds tightened consistently, reflecting improved economic conditions; in the case of Mexico, this trend culminated in an upgrade to investment-grade and an exit from the EM Index.[2] In contrast, the spread of Brazilian bonds exploded in June 2002 following a domestic political crisis.

Figure 6 reports the hedge ratios estimates for the various countries. As before, we perform two sets of regressions, one for the entire period and then separately by spread regime without a spread slope factor. Several key points are evident when looking at the results. First, the entire-period results reveal that the spread slope coefficient is negative and significant for all countries but Turkey. As we expected, the fraction of total return variation explained by changes in yield (as measured by R^2) varies substantially from one country to another. It ranges from a high of 28% for Mexico to a low of 2% for Turkey and the Philippines. Second, as seen in Figure 3, the hedge ratios decrease as we move from the "tight" spread regime to the "wide" spread regime.[3] They range from 0.28 to 0.76 in the "tight" spread regime and

[2] For this reason, all the subsequent analysis shown for Mexico is based on data only up to January 2005.

[3] Note that the determination of the spread levels and observation dates corresponding to each spread regime was carried out independently for each country.

Figure 6. **Regression Estimates of Empirical Hedge Ratios by Country**
Daily Data, January 2000-April 2005

	Mexico	**Brazil**	**Russia**	**Turkey**	**Philippines**
Current Weight in Index (%)	**0.0%**	25.0%	24.0%	8.6%	6.8%
Number of Bonds	**0**	37	33	15	18
Minimum OAS	1.31	2.94	1.78	1.96	3.14
Maximum OAS	4.55	29.64	21.47	12.33	7.17
Entire Period					
Hedge Ratio	1.001	1.435	0.494	0.466	0.798
t-Stat	14.86	7.88	5.97	3.37	4.22
Spread Slope Coefficient	-0.21	-0.158	-0.048	-0.03	-0.14
t-Stat	-8.74	-5.78	-2.46	-1.42	-3.62
Adjusted R^2	27.90%	5.3%	4.7%	1.9%	1.9%
"Tight" Period					
Hedge Ratio	0.619	0.76	0.453	0.43	0.282
t-Stat	19.76	7.43	9.13	5.49	5.44
Adj. R^2	48.1%	11.9%	15.9%	6.4%	6.3%
"Neutral" Period					
Hedge Ratio	0.231	0.445	0.071	0.062	0.053
t-Stat	4.71	4.32	1.18	1.08	0.93
Adjusted R^2	5.0%	4.1%	0.0%	0.0%	0.2%
"Wide" Period					
Hedge Ratio	0.239	-0.433	0.25	0.206	-0.033
t-Stat	6.04	1.69	1.13	1.24	-0.46
Adjusted R^2	7.8%	0.0%	0.0%	0.0%	0.0%

are virtually zero in the "wide" spread regime (except for Mexico). Notice that although higher hedge ratios are typically associated with higher R^2, this is not always the case. For example, in the "tight" regime, the hedge ratio for Brazil is 0.76 with an R^2 of 12%, whereas the hedge ratio for Mexico is lower (0.62) despite the fact that yield changes play a much larger role in explaining the returns to Mexican bonds. The low R^2 for Brazil is due to the huge credit event in 2002, which was not due to the effect of Treasury yields; this does not change the fact that Brazil returns have tended to react quite strongly to changes in U.S. rates.

Conclusion

This paper extends the analysis presented in the recent Lehman Brothers publication "Empirical Duration of Credit Securities: Dependence on Spread" to emerging markets. Similar to U.S. credit, the analysis confirms that empirical duration is sensitive to the spread environment and, in particular, increases as spreads tighten.

Despite the fact that the overall sensitivity of emerging market credit to changes in U.S Treasury yields is not high, we are currently in a "tight" spread regime that implies that interest rate risk is meaningful and should not be overlooked. A quick glance at Figure 5 shows that EM spreads have been rather docile in the past 18 months or so; we therefore recalculated the empirical hedge ratios for each country (and for the index overall) using only data since December 31, 2003. Figure 7 presents the hedge ratio, average spread, annualized spread volatility, and R^2 calculated using just this recent data. The hedge ratio for the overall index is 0.69, and almost one-third of the total return variation can be attributed to changes in Treasury yields. Even for Russia and Brazil, the explanatory power of the regressions is equal to or above 20%, with hedge ratios of 0.64 and 1.13, respectively. The hedge ratio figure for Russia agrees surprisingly well with those for Mexico and Turkey (and the EM Index as a whole) for this period. However, the results for the Philippines show that for at least some high spread countries, the traditional EM market paradigm still prevails, and the Treasury exposure represents a largely insignificant part of the risk profile. Perhaps the key take-away is that as an emerging market converges toward investment-grade, investors need to pay more attention to Treasury duration.

Figure 7. **Hedge Ratio Estimates for the Current Environment**
Daily Observations, January 2004-April 2005

Index	R-Squared (%)	Hedge Ratio	Average Spread	Spread Vol (Annualized)
Global	30	0.69	359	100
Mexico	52	0.73	165	58
Brazil	20	1.13	431	193
Russia	27	0.64	252	101
Turkey	10	0.63	315	174
Philippines	4	0.23	427	107

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