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HIGH-YIELD INDEX REPLICATION

For years, fixed-income managers have invested outside the U.S. aggregate benchmark in search of additional risk-adjusted returns. Over time, many plan sponsors have grown comfortable with these out-of-index investments and have begun to evaluate fixed-income managers versus a broader U.S. dollar-denominated fixed-income investment universe. Consequently, plan sponsors are increasingly turning to the U.S. Universal Index as an appropriate benchmark. The U.S. Universal Index includes the U.S. Aggregate Index (87.1% of the total market value, as of January 31, 2001) plus five other indices: the Corporate High Yield (4.3%), Eurodollar (4.2%), Emerging Markets (2.7%), 144A (1.2%), and High Yield and non-ERISA CMBS (0.5%).

For some investors, a Universal Index mandate may raise certain management issues. Managers with a good record of outperforming the Aggregate Index may have limited experience in some of the other markets that compose the Universal Index. Managers run the risk of missing mandates if they wait while building expertise in the Universal Index sectors new to them. On the other hand, if a mandate is granted before the necessary expertise is in place and the manager is ready to actively trade versus the index, there is a risk of increased tracking error.

Not all managers will choose to develop in-house expertise in every sector of the Universal Index. Some sectors may be deemed too small to justify the cost of mastering markets that are brand new to the manager. However, if the investment mandate specifies the Universal Index as the benchmark, the manager has to allocate an appropriate share of the assets to all sectors. While active management with its search for outperformance may not be the goal in a particular small sector of the index, the manager needs a safe way to track this sector with an acceptable tracking error. This need is especially important because some of the small additions to the Aggregate Index are very volatile and can affect the overall portfolio risk in spite of their low market value share.

Of the five additional indices in the Universal Index, the Eurodollar and 144A indices are relatively straightforward to replicate, as their behavior is similar to the Aggregate Index itself. The CMBS Index is relatively small and can be ignored with few adverse effects. The two remaining indices, the Emerging Markets Index and the High Yield Index, pose a challenge, as they make up a significant part of the Universal Index and their returns are volatile and behave very differently from the returns of the Aggregate Index. In this article, we focus on replication of the High Yield Index. In a forthcoming article, we will tackle the Emerging Markets Index.

Replication of the Lehman High Yield Index

At first glance, the High Yield Index might seem a difficult index to replicate. From January 1993 through December 2000, the monthly mean excess (curve-adjusted) return over Treasuries was -0.3 bp, with a monthly standard deviation of 162 bp. In contrast, over the same period, the U.S. Credit Index had a monthly mean excess return of -1.2 bp and a monthly standard deviation of 48 bp. The relatively high excess return volatility of the High Yield Index gives a hint of the potential difficulty of creating a replicating portfolio with a relatively low tracking error.

Total returns of the two indices are similar. From January 1993 through December 2000, monthly mean total returns were 57 bp and 59 bp for the High Yield and Credit indices, respectively. The poor high yield performance in 2000 brought down the average for the entire eight-year period. The monthly standard deviations of total returns were 149 bp and 139 bp for the High Yield and Credit indices, respectively. Although the excess returns for high yield are more volatile, they tend to be negatively correlated with the term structure returns. As a result, the volatility of total returns for the High Yield Index is similar in magnitude to that of the Credit Index. These numbers show that most of the total return volatility in the Credit Index is due to Treasury volatility. Stripping Treasury volatility from the 139 bp of total volatility leaves excess returns volatility of only 48 bp. In stark contrast, stripping Treasury volatility from the High Yield Index total volatility of 149 bp leaves 162 bp.

We present three strategies for replicating the High Yield Index. First, we describe each strategy, and then we compare the strategies' empirical performance simulated historically over the period of eight years from January 1993 through December 2000.

Issuer Strategy

The first replication strategy is simple. It selects securities for the replicating proxy portfolio from the list of the largest issuers in the index. The proxy portfolio is constructed as follows:

Step 1: Compute each issuer's market value percentage in the index.

Step 2: For each of the largest N issuers (N is a strategy parameter), choose the largest bond from each issuer. This step produces N bonds eligible for inclusion in the proxy portfolio.

Step 3: The percentage of the proxy's market value allocated to each of the N bonds is determined so that the allocation ratio of any two bonds in the proxy equals the market value ratio of the two issuers in the index. For example, if issuers A and B account for 1.5% and 1% of the index, respectively, then the ratio between market values allocated to these issuer's largest bonds is 1.5:1.

The issuer strategy assumes that idiosyncratic risk is a key component of returns in the high yield market. The strategy does not explicitly control for Treasury duration. As a result, the duration of the proxy may not equal that of the index. On average, over the period studied, the Treasury duration of the proxy differed from the index by 0.25 year. This should not be viewed as a serious drawback of this strategy. As we showed before, most total return volatility for high yield is not due to term structure volatility. As a result, the issuer strategy is motivated by the view that idiosyncratic risk is a key component of returns in the high yield market, and matching issuer exposures should be a key feature of a successful replication strategy.

Structure Strategy

Another approach is a structure replication strategy that divides the High Yield Index into industry and credit "buckets" and then selects eligible bonds to populate each bucket. The strategy first computes the market value weight and the contribution to dollar spread duration for each bucket. Then, the replicating proxy portfolio is constructed so that in each bucket, the market weights and contributions to spread duration match those of the index. This procedure ensures that the proxy portfolio's overall spread duration matches that of the index. In addition, this strategy also matches the Treasury duration of the index. Finally, not only the duration but also the convexity of the proxy portfolio matches that of the index.

Because idiosyncratic risk is a large factor in a high yield bond's return variability (compared with investment grade bonds), the strategy imposes a demanding set of eligibility criteria (described below) in an attempt to avoid bonds with a potential for high returns volatility. The number of bonds placed in each bucket (a diversification constraint) is also based on the bucket's historical behavior. This requirement helps to further diversify idiosyncratic risk.

The structure replication strategy works as follows. It defines fifteen buckets, of which ten are industry buckets and five are quality buckets. Each bond in the replicating proxy portfolio will belong to only one industry bucket and to only one quality bucket.

The ten industry buckets are:

1. Utilities
2. Financial
3. Telecommunications-B (quality B3 or better)
4. Telecommunications-C (quality less than B3)
5. Media
6. Cyclical
7. Industrial
8. Sovereign
9. Foreign Agency
10. Foreign Corporation

The five quality buckets are:

1. Greater than B1
2. B1
3. B2
4. B3
5. Less than B3

Except for subdividing the telecommunications sector based on quality, the structure strategy does not create buckets defined in terms of *both* industry and quality as is common with some replication strategies for the Credit Index. In other words, it does not define a utilities bucket with a quality of B3. We found that dividing the High Yield Index into a larger

number of smaller buckets (division along both industry and quality would result in fifty buckets) does not improve tracking error.

Because the sovereign, foreign agency, and foreign corporation buckets combined represent less than 1% of the market value of the High Yield Index, the proxy portfolio is not required to match those buckets in terms of market value percentage or contribution to spread duration.

Not all bonds in the index are eligible for inclusion in the proxy. As mentioned before, we exclude bonds that have the potential for wild swings in returns and could result in high tracking errors for the proxy portfolio. To be eligible for inclusion in the proxy portfolio a bond must meet the following inclusion criteria:

Return Volatility—The bond's excess return for the previous month must be within three standard deviations of the bond's industry bucket mean return (provided that the bucket contains at least ten bonds);

Age—The bond must be at least one month old; and

Distress Status—If the bond pays a coupon, its full price must be at least 60% of par, and, for all bonds, the yield to worst can not be more than 1,000 bp greater than the average yield to worst for its quality bucket.[1]

To ensure diversification within the proxy portfolio, we place an upper limit on the percentage of the proxy's market value contributed by each bond. Unlike the issuer replication strategy, this strategy looks at *bond* diversification, not *issuer* diversification. This upper limit varies from bond to bond and is set as the minimum of:

- the global upper limit that applies to all bonds, *e.g.,* 2%
- the upper limit for the bond's quality bucket
- the upper limit for the bond's industry bucket

The last two upper limits depend on how important it is to have bond diversification in a particular bucket. For example, if the B3 bucket has a high standard deviation of total returns across all bonds in the bucket, then we require a lower upper limit for that quality bucket. By requiring a lower upper limit, we force the proxy portfolio to hold more bonds from that quality bucket in order to match the bucket's market weight. This method increases diversification in those buckets in which it is most needed.[2]

Securities for the proxy portfolio are selected from among all eligible bonds using linear optimization. The objective function is to maximize the amount outstanding (*i.e.,* liquidity) of the proxy portfolio subject to the constraints outlined above.

The expectation was that the structure strategy might perform better than the issuer strategy because it explicitly takes into account the industry and quality structure of the High Yield Index when constructing the proxy portfolio. As we show below, it actually does *not* perform better, indicating that issuer diversification must remain an integral part of the proxy portfolio construction. This result led us to the third replication strategy.

Structured-Issuer Strategy

The third replication strategy is similar to the second one, except that this strategy filters the list of eligible bonds further. The final list contains no more than one bond (the one with the largest market value) from every issuer in the index, to force more issuer diversification. Otherwise, this strategy follows the same methodology as the structure strategy described above. The added filtering also turns the upper limits on individual bonds (as in the second replication strategy) into upper limits on individual issuers (as in the first replication strategy), thus increasing diversification.

This strategy combines the emphasis on issuer diversification of the first strategy with the emphasis on index structure matching

[1] Excluding distressed bonds from the proxy portfolio significantly improves the proxy portfolio's tracking error. Since the proxy contains many fewer bonds than the index, the presence of distressed bonds in the proxy over-emphasizes the variability of their returns.

[2] Consider the following example. The standard deviation of returns within the B1 quality bucket was 487 bp, while the standard deviation within the less-than-B3 bucket was 1,058 bp. Therefore, the upper limit on the market value allocated to any bond from the B1 bucket was 3.23%, while the upper allocation limit in the less-than-B3 bucket was 0.68%. Details of the method for computing the upper limits for the industry and quality buckets can be provided upon request.

of the second strategy. As a result, the tracking error it produced was the lowest of all three strategies.

Replication Results

We examined the performance of all three replication strategies for the period from January 1993 through December 2000. For the issuer strategy, five simulations were conducted. Each simulation used a different number of issuers (N) in the proxy portfolio. The values of N examined were 20, 40, 60, 80, and 100. For both the structure and the structured-issuer strategies, two historical simulations were conducted. The first had a global upper limit of 2% (which produced an average portfolio size of 78 bonds for both strategies). The second used a global upper limit of 4% (which produced an average portfolio size of 46 bonds for both strategies). Figure 1 presents the tracking errors obtained in every case.

For proxy portfolios with a similar number of issues, the issuer strategy is somewhat better than the structure strategy. For example, with a 40-issue proxy portfolio, the issuer strategy produces an average monthly tracking error of 69 bp (explaining 79% of the variability of the index), compared with 67 bp for the structure strategy containing 46 issues.

However, the structured-issuer strategy produces the lowest tracking error of all three strategies: for example, for proxy portfolios of 80 issues, 38 bp versus 51 bp for the issuer strategy. A summary graph of these results is presented in Figure 2.

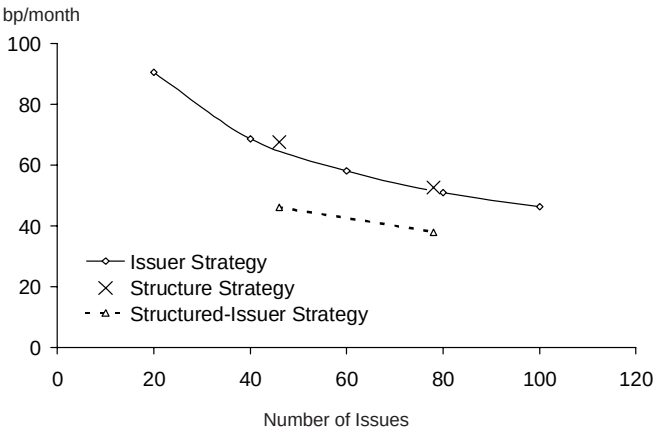
There are several reasons that the issuer strategy, which does not explicitly match industry, quality, duration, and other characteristics of the index, performed better than the simple structure strategy. First, the idiosyncratic (issuer) risk of high yield bonds is much greater than that of investment grade bonds. This makes issuer diversification at least as important as market risk factor matching, especially in a small to medium-sized portfolio. Second, in recent years, the highly liquid (*i.e.*, large issue size) component of the High Yield Index has had a composition similar to that of the index as a whole in terms of duration, industry, and quality exposures. Consequently, the issuer strategy produced a proxy portfolio with a composition similar to that of the index. Third, when constructing a small proxy portfolio using the structure strategy, we may pick multiple bonds from the same issuer and suffer higher tracking error due

Figure 1. **Performance of the Three Replication Strategies versus the High-Yield Index,** January 1993-December 2000

No. of Issues	Monthly Mean Outperformance (bp/month)	Monthly Tracking Error (bp/month)	% of Variance Explained
Issuer Strategy			
20	18.8*	90.4	63.4
40	11.4	68.6	78.9
60	8.3	58.0	84.9
80	8.5	50.9	88.4
100	8.1	46.2	90.4
Structure Strategy			
46	4.6	67.4	79.6
78	2.3	52.6	87.6
Structured-Issuer Strategy			
46	4.7	46.1	90.5
78	0.8	37.9	93.6

* The high monthly mean outperformance values for the issuer strategies with relatively few issues may be due to the fact that bonds from the largest issuers performed best during the periods of market stress in the last few years due to their liquidity advantage.

Figure 2. **Performance Comparison of Three Replication Strategies Tracking Error versus Number of Issues** January 1993-December 2000



to poor issuer diversification. In addition, we may be forced to select one or two relatively small issuers in order to match all the constraints. Given the small number of bonds in the portfolio, this may cause significant issuer mismatches and relatively high levels of idiosyncratic risk.

Another way to look at the performance results is to plot tracking error versus the number of *issuers* in the proxy portfolio (Figure 3). Some investors may feel that the number of issuers in the proxy portfolio is a better measure of the cost of monitoring the portfolio than the number of issues. Recall that the structure strategy forces diversification at the bond level, whereas the other two strategies force diversification at the issuer level, which is more stringent.

Figure 3 shows that the structure strategy now performs a bit better than the issuer strategy. For example, while the structure strategy with a global upper limit of 2% holds 78 bonds, it holds only 63 issuer names.

Overall, the structured-issuer strategy with a global upper limit per bond of 2% proved the most successful. This strategy considers both issuer diversification and market risk factor matching. If at some point in the future, liquid (*i.e.*, top market value) bonds in the high yield market become concentrated in a particular industry or quality, the structured-issuer strategy should continue to work reasonably well, while the issuer strategy may be exposed to significant sector and market factor risk.

Figure 4 shows the actual performance of the structured-issuer strategy with a global upper limit per bond of 2% and the High Yield Index for January 1993 through December 2000.

Conclusion

We have presented three replication strategies for the High Yield Index and have examined their empirical performance from January 1993 through December 2000. Based on these results, we have learned that matching issuer exposures is a key feature of a successful replication strategy, as is matching the industry and quality structure of the index. Consequently, we recommend the structured-issuer strategy as the best replication technique. As a result of this work, several investors are now exploring this technique to track the High Yield Index passively.

Figure 3. **Performance Comparison of Three Replication Strategies Tracking Error versus Number of Issuers**
January 1993-December 2000

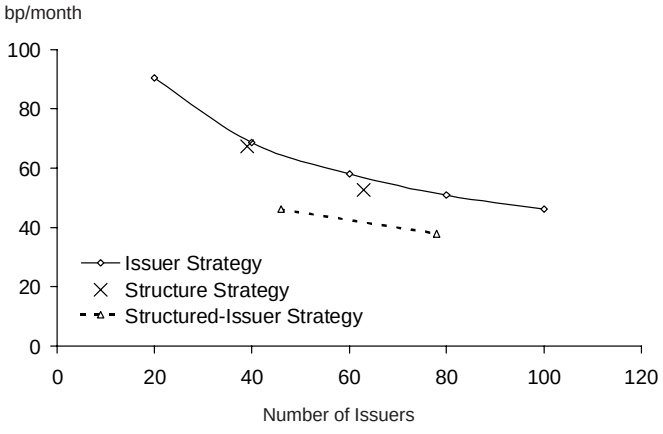


Figure 4. **High Yield Index Return versus Structured-Issuer Proxy Portfolio Return (78-Issue Portfolio)**
January 1993-December 2000, bp/month