



Pension Solutions' Insights

Managing Pension Liability Credit Spread Risk II: An Update



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This paper is an update to “Managing Pension Liability Credit Spread Risk” in the Fall 2009 issue of *Journal of Portfolio Management*.

Abstract

Volatile corporate bond credit spreads have caused a dislocation of corporate bond-based pension discount rates from the rates of commonly used interest rate hedging tools and have driven the question of how to manage liability credit spread risk to the forefront of plan sponsors’ minds. Whereas managing liability interest rate risk via interest rate swaps and/or Treasuries is relatively straightforward, managing liability credit spread risk is more challenging for three important reasons: (1) the credit spread component of liability returns is not investable, (2) there is no capital-efficient risk management tool to hedge liability credit spread risk, and (3) the connection between credit spreads and the returns of common risky assets (i.e., equities) is relatively reliable – especially during periods of economic stress when risky return generating assets typically fall as credit spreads widen. Therefore, in order to construct efficient liability driven solutions and avoid poor funding ratio outcomes, it is essential to view the liability credit spread risk from a total portfolio perspective inclusive of the “risky” asset component of the overall portfolio. As a general rule, from a long-term policy perspective, the larger and more equity-like the composition of the risky asset portfolio, the less plan sponsors should utilize credit risk in the liability hedge. However, from a tactical perspective, adding credit risk to the liability hedge when credit spreads are deemed wide and expected to narrow can improve funding ratio outcomes. And, when tactically adding credit risk to the hedge, the amount of credit risk taken must be scaled appropriately in a total portfolio context.

Volatile interest rate and credit spreads during the three year period ending June 30, 2010 had a significant impact on pension fund liabilities and funding ratios. While US interest rates fell over 200 basis points (bps) for the three year period ending June 30, 2010, pension discount rates fell only 75bps. Pension discount rates dropped modestly because pension liabilities are discounted using yields on high-quality corporate bonds, and for the same period, corporate bond credit spreads widened significantly, partially offsetting the drop in interest rates. Widening credit spreads have dampened the decrease in pension discount rates and the corresponding increase in present value of pension liabilities. As a result, pension funding ratios have been buoyed as equity markets fell severely. Plan sponsors that have implemented liability hedges via interest rate swaps and/or Treasuries have seen their liability hedge appreciate in value significantly as interest rates fell severely. However, their liability has increased by a much smaller amount than the hedge portfolio as pension discount rates fell modestly causing, in this case, a liability hedging gain.

The widening of credit spreads during the credit crisis and the corresponding liability hedging gains have raised a very important question for those that have implemented a Liability Driven Investing (LDI) solution or are considering LDI: how should a plan sponsor manage the risk of corporate bond credit spreads widening or narrowing? We believe many practitioners have taken too narrow a view of this question and evaluated liability credit spread risk as a pure liability hedging issue. The main points in what follows are that in order to construct efficient LDI solutions and avoid poor funding ratio outcomes, it is essential to (1) recognize that liabilities may have a regulatory driven credit spread risk but do not have an economic credit risk and (2) view the liability credit spread risk from a total portfolio perspective inclusive of the “risky” asset component (i.e., equities) of an overall LDI solution.

It is important to note that this article is not an endorsement of including a credit spread in pension liability discount rates and that we agree with the economists who argue that there is no economic justification for doing so. In fact, incorporating a credit spread leads to chronic underfunding on a riskless basis, and as discussed in detail throughout this article, makes it more difficult to hedge liability discount rate risk. However, the current regulatory environment does utilize a credit spread in pension discount rates and, for those plan

sponsors that choose to manage it, this article should be viewed as a guide for how best to do so.

Understanding pension liability discount rate risk

We start with an in-depth discussion of pension liability discount rate risk. The present value of a liability is determined in two steps – by establishing the cash-flow profile of expected benefit payments and then discounting the future payments at the appropriate discount rate. Liability return is the change in the present value of liabilities from one period to the next and is primarily attributable to two sources: (1) the passage of time and (2) changes in the discount rate. Liability risk is the volatility of liability returns and is primarily driven by changes in the discount rate.¹

Of course, the liability return will depend on the discount rate used. According to the Pension Protection Act (PPA) and the Financial Accounting Standards Board (FASB), expected pension benefit payments are to be discounted using a discount curve that is based on the yields of high-quality corporate bonds. Any change in the high-quality corporate bond yield curve will change the discount curve, which in turn, will change the present value of the liability. Changes in the corporate bond yield curve can be decomposed into changes in the: (1) the LIBOR interest rate swap curve and (2) the corporate bond credit spread curve (relative to LIBOR). Therefore, we can split liability discount rate risk into interest rate risk (the risk of the LIBOR interest rate swap curve changing) and credit spread risk (the risk of corporate bond credit spreads relative to LIBOR changing).

We define interest rate risk as the risk of any change in the LIBOR interest rate swap curve. We choose the LIBOR interest rate swap curve instead of the Treasury curve as it is an extremely liquid, customizable, and capital-efficient tool for implementing interest rate hedges for pension liabilities. Further, we believe it is credit risk-free enough for our purposes.² Exhibit 1 highlights, for the 13+ year period ending June 30, 2010, liability returns for a typical pension liability profile based on a corporate bond-based discount curve and compares them with the LIBOR interest rate swap-based component of liability return. We will refer to this same 13+ year period throughout the article as the aggregate period. Ideally, we would see the swap-based liability return match the corporate bond-based liability return. If it did, we could then just use interest rate swaps to hedge corporate bond-based pension liabilities. However, Exhibit 1 indicates

that swaps are a good hedge in most periods but not a perfect match. The correlation between the two returns was approximately 0.73 for the entire period.

Exhibit 1: Corporate bond-based vs. swap-based liability returns (1/1/1997-6/30/2010)



Sources: Legal & General Investment Management America, Bank of America Merrill Lynch

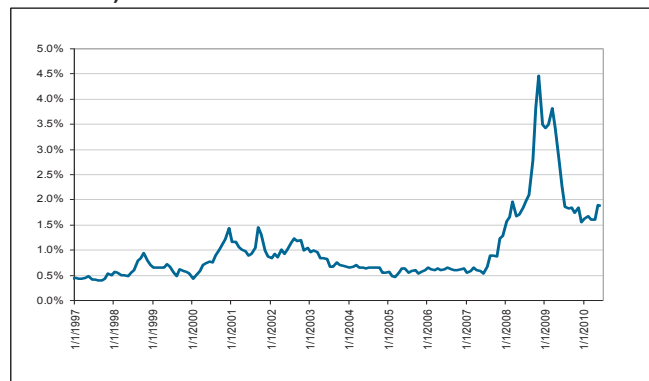
Note: Corporate bond-based liability returns are based on the Bank of America Merrill Lynch Average US Pension Plan AAA-A Liability Index. Swap-based liability returns are based on a duration neutral (relative to the liability benchmark) blend of the Bank of America Merrill Lynch Young US Pension Plan Swap Liability Index and the Bank of America Merrill Lynch Retired US Pension Plan Swap Liability Index.

The difference between the corporate bond-based liability returns and the swap-based liability returns in Exhibit 1 is attributable to the corporate bond credit risk embedded in the liability discount curve which does not exist in the LIBOR interest rate swap curve. We will refer to this component of corporate bond-based liability return as liability credit spread return and the volatility of these returns as liability credit spread risk.

When the spread between the corporate bond-based liability discount curve and the LIBOR interest rate swap curve widens or narrows it causes either a positive or negative liability credit spread return. For example, when corporate bond spreads widen, the liability credit spread return will be negative because, all else equal, higher corporate bond credit spreads increase pension discount rates and lower the present value of liabilities. The large negative liability credit spread returns in 2007-2008 highlight the impact of credit spreads widening during the 2007-2008 credit crisis. On the other hand, when corporate bond credit spreads narrow, liability credit return will be positive as, all else equal, lower corporate bond credit spreads decrease pension discount rates and increase the present value of liabilities. This was the case in 2003-2004 and more severely in 2009.

Exhibit 2 tracks the liability discount rate spread over the aggregate period for the same typical liability profile analyzed in Exhibit 1. This spread represents, for a typical liability profile, the difference between the corporate bond-based liability discount rate and a LIBOR interest rate swap-based discount rate. If this liability discount spread was stable we would see no volatility in liability credit spread returns. However, the liability discount spread is not stable and is cause for the volatility of the mismatch in returns seen in Exhibit 1.

Exhibit 2: Liability discount rate spread (1/1/1997-6/30/2010)



Sources: Legal & General Investment Management America, Bank of America Merrill Lynch

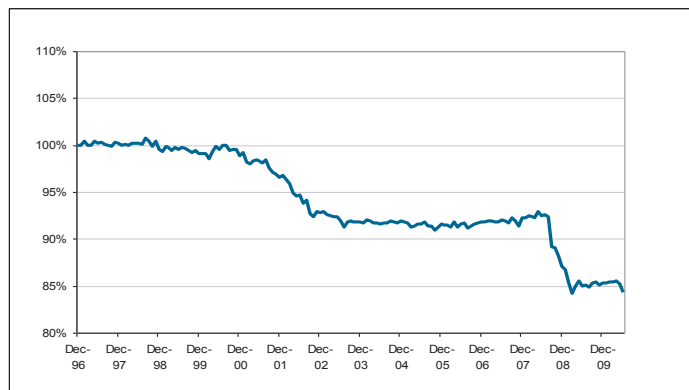
Interestingly, credit spread risk tends to partially offset interest rate risk. In other words, in most periods when interest rates have risen (fallen), credit spreads have narrowed (widened). For example, during the 2000-2002 recession, pension discount rates fell approximately 150bps due to interest rates falling approximately 210bps which was partially offset by a 60bps widening in corporate bond spreads. For the periods between the 2000-2002 recession and the 2007-2008 credit crisis, pension discount rates remained roughly the same. However, during these periods interest rates rose by approximately 70bps. Coincidentally, credit spreads narrowed by an almost perfectly offsetting amount resulting in no change to pension discount rates. The 2007-2008 credit crisis saw pension discount rates rise by 70bps despite interest rates falling by over 250bps. This is explained by credit spreads widening by over 300bps and more than offsetting the drop in interest rates. While credit spread risk tends to offset interest rate risk, importantly, it is difficult to tell whether it will partially, fully, or more than offset interest rate risk.

Liability credit spread risk can be thought of as corporate bond credit spread risk. However, there is one very important difference: *corporate bond returns have credit risk and credit spread risk whereas liability returns only have credit spread risk*. This point is relevant for any pension liability benchmark that uses corporate bond yields to discount liabilities (i.e., Pension Protection Act (PPA) discount curve or the Citigroup Pension Liability Discount Curve). Essentially, the issue is that corporate bond-based liability returns are not subject to default and downgrade risk whereas any investment in corporate bonds certainly is.

For example, consider a plan that, in an effort to immunize the plan, invests in the corporate bonds that underlie the pension discount curve. What happens if a bond in the portfolio defaults during the next month? The asset portfolio certainly takes a loss on that position. However, the liability return will not be exposed to the loss as the pension discount curve simply kicks that bond out of its universe and the discount curve used at the end of the month to revalue the liability may even decrease (as the weakest bond is dropped from the index) causing the liability to actually increase in value.

To illustrate the credit risk-free nature of corporate bond-based liability returns, we tracked the funding ratio over the aggregate period for a hypothetical pension plan which invested 100% of plan assets in long duration corporate bonds with the same duration and credit profile of its liability. Exhibit 3 highlights the performance of this hypothetical plan's funding ratio which starts at 100% and finishes with a funding ratio of 84%. It is evident that this corporate bond investment strategy – which is subject to default and downgrade risk – will not be able to keep up with the uninvestable corporate bond-based liability benchmark, which is not subject to default and downgrade risk. The point here is not to imply that corporate bonds have no place in managing liability discount rate risk, but rather to make the point that they are far from risk-free. It is worth noting that this tracks a passive investment in long duration corporate bonds and ignores any potential benefits from actively managing the bond portfolio. To the extent that an active manager could avoid downgrades and defaults these large funding ratio drawdowns could be mitigated.

Exhibit 3: Funding ratio for long duration corporate bond immunization strategy



Sources: Legal & General Investment Management America, Bank of America Merrill Lynch

Note: Funding ratio (end of year) = funding ratio (beginning of year) * (1+ funding ratio return). Funding ratio returns is equal to the annualized monthly funding ratio returns. Monthly funding ratio returns calculated as (asset return- liability return) / (1+ liability return). For more details on measuring and interpreting funding ratio performance see Leibowitz et al. [1991]. Asset returns

are equal to the returns of the Barclays Capital Long Credit (credit quality A or better) Index. Liability returns are based on a duration neutral (relative to the asset benchmark) blend of the Bank of America Merrill Lynch Young US Pension Plan AAA-A Liability Index and the Bank of America Merrill Lynch Retired US Pension Plan AAA-A Liability Index. We ignored benefit payments and assumed no service cost or contributions.

Improving the effectiveness of the liability hedge

There is no simple solution to the liability credit spread risk problem. Because liability credit spread returns are not investable, liability credit spread risk can only be managed as opposed to eliminated. To do so, we start by analyzing two options of getting investment grade corporate bond credit spread risk into the portfolio to improve the effectiveness of an interest rate swap-based liability hedge. We will look at: (1) investment grade corporate bonds, and (2) an investment grade Credit Default Index (CDX).

Rather than only analyzing these assets and their liability credit spread risk management potential over the aggregate time period, we will also split the aggregate period into five sub-periods which isolate three credit events, and also analyze each of the assets within these five sub-periods:

1. January 1, 1997 – March 31, 2000: Liability discount spread stable
2. April 1, 2000 – September 30, 2002: Liability discount spread widened 60 bps
3. October 1, 2002 – June 30, 2007: Liability discount spread narrowed 65 bps
4. July 1, 2007 – March 31, 2009: Liability discount spread widened 330 bps
5. April 1, 2009 – June 30, 2010: Liability discount spread narrowed 200 bps

When evaluating the increase in effectiveness of the liability hedge we use, as a frame of reference, the effectiveness of the swap-based hedging strategy seen in Exhibit 1. Exhibit 4 summarizes the performance of the swap-based strategy over the entire period as well as the five sub-periods and compares it with a corporate bond-based hedging strategy and a swap + CDX hedging strategy.

Exhibit 4: Comparison of hedge effectiveness – (1/1/1997-6/30/2010)

Time Period	Dates	Liability Return	Swap Based Hedge			Corporate Bond Hedge			Swaps + CDX		
			Return	Correlation with Liability Return	Tracking Error	Return	Correlation with Liability Return	Tracking Error	Return	Correlation with Liability Return	Tracking Error
1	1/1/1997-3/31/2000	20%	20%	93%	2.3%	19%	98%	1.1%	N/A	N/A	N/A
2	4/1/2000-9/30/2002	43%	49%	82%	4.8%	34%	96%	1.9%	N/A	N/A	N/A
3	10/1/2002-6/30/2007	28%	16%	98%	1.9%	27%	99%	1.0%	N/A	N/A	N/A
4	7/1/2007-3/31/2009	3%	45%	54%	15.4%	-5%	98%	3.2%	18%	75%	11.8%
5	4/1/2009-6/30/2010	31%	2%	38%	10.5%	31%	98%	1.7%	14%	62%	6.7%
Aggregate	1/1/1997-6/30/2010	198%	208%	71%	7.3%	151%	98%	1.7%	N/A	N/A	N/A

Sources: Legal & General Investment Management America, Bank of America Merrill Lynch, Bloomberg

Note: Liability returns are based on a duration neutral (relative to the corporate bond benchmark) blend of the Bank of America Merrill Lynch Young

US Pension Plan AAA-A Liability Index and the Bank of America Merrill Lynch Retired US Pension Plan AAA-A Liability Index. Swap-based liability returns are based on a duration neutral (relative to the liability benchmark) blend of the Bank of America Merrill Lynch Young US Pension Plan Swap Liability Index and the Bank of America Merrill Lynch Retired US Pension Plan Swap Liability Index. The corporate bond hedge returns are equal to the returns of the Barclays Capital Long Credit (credit quality A or better) Index. The swaps + CDX returns are equal to the swaps-based hedge returns plus the return of a CDX 5-year investment grade scaled to match the duration of the liability. Correlations are based on monthly returns and tracking errors are annualized based on monthly differences between the various hedge returns and the liability returns.

As discussed earlier and illustrated in Exhibit 3, corporate bonds will not perfectly match liability returns. Exhibit 4 summarizes the performance of the same long duration corporate bond portfolio relative to same liability returns over the aggregate period as well as the five sub-periods. Since the bond portfolio was constructed to match the interest rate and credit spread risk profile of the liability benchmark, the difference in performance is primarily attributable to differences in the uninvestable component of liability credit spread returns.

During economically stressful periods such as the 2000-2002 recession and the 2007-2008 credit crisis, corporate bonds underperformed the liability benchmark as downgrades and defaults inflicted a drag on the assets but not the liabilities. Overall, the tracking error to liabilities is relatively low across all periods compared to a swap-based hedge, and, in an absolute sense, very low during relatively good economic periods. For the aggregate period, corporate bonds would have increased the effectiveness of a liability hedge as tracking error, which can be thought of as funding ratio volatility, fell from 7.3% to 1.7%. Essentially, the vast majority of the risk that remains is attributable to the uninvestable nature of corporate bond-based pension liability returns.

Thus far, the analyses of corporate bond-based hedges have been limited to investment grade bonds with a credit rating that is representative of the credit risk in pension discount curves – A or better credit rating. In order to improve diversification or yield, some may consider expanding to incorporate weaker rated bonds. Generally, weaker credit in hedging assets is expected to offer worse relative performance during bad economic environments and should be utilized with caution. Most importantly, weaker credit will experience more defaults and downgrades during bad economic periods such as the 2000-2002 recession – precisely the time when sponsors can tolerate hedging losses the least.³

In summary, a corporate bond-based hedge would have clearly improved the effectiveness of the liability hedge. However, importantly, a corporate bond-based hedge only improved funding ratio outcomes during good economic periods and resulted in far worse outcomes during the economically stressful periods. Further, and most importantly, for plans that are heavily invested in risky return generating assets (i.e., equities) that perform poorly during economically stressful periods, investing liability hedging assets in corporate bonds would have exacerbated the funding ratio pain during these stressful periods. This issue is discussed in more detail later.

While corporate bonds require full capital investment, a credit default swap provides a capital-efficient way to introduce investment grade corporate credit into a portfolio. As an illustration, exposure to an investment grade CDX was added to the swap-based hedge to evaluate any incremental

improvement in hedging effectiveness. Exhibit 4 summarizes the results for the 2007–2008 credit crisis (because the CDX started in March 2004, data is not available for the other time periods).

Adding CDX offers a small amount of improvement to the effectiveness of a swap-based hedge. During the 2007–2008 period, correlation increased and the tracking error decreased from 15.4% to 11.8%. And, for sake of fair comparison, for the entire March 2004–June 2010 period, the tracking error of a swap-based hedge and a swaps + CDX hedge were 10%, and 7.1% respectively. While the addition of CDX to the swap-based hedge improves the effectiveness of the hedge, it still leaves a significant amount of tracking error. This is a bit surprising given that CDX exposure is meant to be representative of corporate bond credit. However, there are a few reasons why using CDX has its limitations for improving the effectiveness of a pension liability hedge.

First, there is a significant amount of basis risk between CDX and its underlying corporate bonds. During the 2007-2008 credit crisis, this basis risk took the form of a very large negative basis where corporate bond yields were almost 400bps higher when compared to the equivalent Credit Default Swaps (CDS) on the same names. Second, CDX instruments are only liquid up to five-year maturity periods while pension liabilities exist well past 30 years. Therefore, when using CDX to duration-match the credit spread exposure of pension liabilities, the credit spread hedge will be significantly exposed to changes in the shape and slope of the credit spread curve. Last, the CDX Investment Grade Index has a great deal of exposure to BBB rated bonds. These BBB bonds are weaker credit than the average corporate bonds underlying pension discount curves which typically do not include bonds below an A rating. In summary, thus far, CDX has not been able to increase the effectiveness of a swap-based hedge to anywhere near the level of a physical corporate bond-based hedge.

Maintaining perspective

Portfolio theory says the optimal manner for managing LDI solutions in an ideal world is to split the asset portfolio into two separate components: (1) a liability hedging component, and (2) an efficient return generating component. The liability hedging component can be implemented in a capital-efficient manner via derivatives allowing the majority of capital to be deployed in excess return generating strategies. And, if all of the liability risks are perfectly hedged, the return generating component can be constructed, in isolation, in an asset-only framework.

However, pension liabilities cannot be perfectly hedged in a capital-efficient manner. In addition, the return generating portfolio often contains exposures to risks that are correlated with the interest rate and credit risks of the liability benchmark – this is especially true during periods of

economic stress. So the return generating assets have some hedging characteristics and the line between the liability hedging component and the return generating component must be blurred, and a plan sponsor must manage LDI solutions in a total portfolio context while considering the risks of return generation and how they correlate with the risks of the liability. Staying within the scope of this paper, we focus our attention on how return generating assets correlate with the credit spread risk component of pension liabilities. To do so, we analyze two common return generating strategies that, we believe, should be considered when managing liability credit spread risk: high yield bonds and equities.

We would expect returns on both high yield bonds and equities to have a positive correlation with liability credit spread returns. High yield bond returns behave like liability credit spread returns since high yield spreads are positively correlated to investment grade bond spreads. And, equity returns tend to be poor in economic environments where credit spreads widen, as investors price in a higher equity market risk premium. We begin by evaluating, for a typical liability profile, how effectively equities and high yield bonds would have hedged liability credit spread risk by analyzing the correlation of equity and high yield bond returns with liability credit spread returns over all periods (Exhibit 5).

Exhibit 5: Performance of risky assets relative to liability credit spread returns – (1/1/1997-6/30/2010)

Time Period	Dates	Change in Liability Discount Spread	Liability Credit Spread Return	Return	Equities				High Yield Bonds				
					Correlation with Liability Credit Spread Returns	Spread Duration			Correlation with Liability Credit Spread Returns	Spread Duration			
						Estimate	90% Confidence Interval			Estimate	90% Confidence Interval		
1	1/1/1997-3/31/2000	0.15%	0%	77%	28%	19	-4	42	0%	52%	12	5	20
2	4/1/2000-9/30/2002	0.61%	-7%	-49%	48%	16	5	28	-16%	47%	11	3	18
3	10/1/2002-6/30/2007	-0.65%	12%	74%	34%	17	4	31	55%	35%	10	2	18
4	7/1/2007-3/31/2009	3.28%	-54%	-48%	49%	8	2	14	-20%	79%	10	7	13
5	4/1/2009-6/30/2010	-1.94%	25%	32%	51%	10	1	19	27%	61%	5	1	8
Aggregate	1/1/1997-6/30/2010	1.45%	-8%	7%	44%	11	8	15	33%	63%	9	8	11

Sources: Legal & General Investment Management America, Bank of America Merrill Lynch, Bloomberg

Note: Liability credit spread returns are equal to the compounded monthly differences between corporate bond-based liability returns and swap-based liability returns. Corporate bond-based liability returns are based on the Bank of America Merrill Lynch Average US Pension Plan AAA-A Liability Index. Swap-based liability returns are based on a duration neutral (relative to the liability benchmark) blend of the Bank of America Merrill Lynch Young US Pension Plan Swap Liability Index and the Bank of America Merrill Lynch Retired US Pension Plan Swap Liability Index. Excess equity (S&P 500 Total Return Index) and high yield bond (Merrill Lynch High Yield Bond Index) returns are equal to the compounded monthly returns over LIBOR. Correlations are based on monthly returns. Spread duration statistics were determined using regression analyses. The dependent variable was the monthly excess return of the respective asset class over LIBOR and the independent variable was the monthly change in the pension discount spread as seen in Exhibit 2.

Correlations for equities and high yield bonds were positive for all periods and quite high during the 2007-2008 credit crunch. For the aggregate period, correlation of equities and high yield bonds to liability credit returns were 0.44 and 0.63, respectively. However, in order to better understand the hedging effectiveness we square the correlations and translate these into R-squared statistics of 0.19 and 0.39, respectively. The R-squared statistics tell us that equity and high yield bond excess returns explained just 19% and 39% of the variance in liability credit spread returns, respectively. These low R-squared statistics indicate that neither equities nor high yield bonds are an effective hedge for liability credit spread risk.

However, what should a plan sponsor do if they have a large allocation to equities or high yield bonds? In our view, it is crucial to understand and incorporate the behavior of equities and high yield bonds in plan sponsors' liability credit spread risk management program. This is because, even though the short term connection between equities, high yield bonds and credit spreads is not stable, it does tend to be positive, and during periods of economic stress, equities often times fall and credit spreads often times widen. And understanding and managing what happens to pension liabilities and assets during periods of economic crisis is essential to effective pension risk management. After all, facing a declining funding ratio in a weak economic

environment is an uncomfortable scenario for both plan participants and the plan sponsor.

To this end, Exhibit 5 also includes the excess returns and spread durations of equities and high yield bonds across all periods. We see that during the 2000-2002 period, credit spreads widened by approximately 60 bps while equities and high yield bonds performed poorly. During this period, if a plan sponsor would have hedged its liability with interest rate swaps it would have had a hedging gain of 7% as a swap-based hedge outperformed the corporate bond-based liability. This may have caused some to question the effectiveness of the liability hedge. However, it is crucial to maintain perspective and incorporate what happened to the return generating portfolio as well. Consider a sponsor with a significant allocation to equities. That sponsor would have had equity losses that more than offset the hedging gain. If this same sponsor would have added significant credit risk to its hedging portfolio, it could have experienced a hedging loss at the same time equities were falling – a very unfavorable funding ratio outcome.

As another example, the 2007-2008 credit crisis is a more extreme case of how a high credit quality hedge could have helped sponsors in a difficult time. As seen in Exhibit 5 and discussed earlier, credit spreads widened over 300 bps from July 2007 through March 2009 causing a swap-based hedge

to outperform the corporate bond-based liability by 54%. Some have asserted this swap-based hedge was ineffective. But it is our view that, with equities returning 48% below cash during this stressful period, a swap- or Treasury-based hedge provided funding ratio protection to plan sponsors with large allocations to equities when they needed it the most.

On the flip side, the period between 2002-2007 is a good example of a period with little economic stress. Over that period, credit spreads narrowed by 65bps and, not surprisingly, risky assets performed well. Spreads narrowing led to, for swap-based hedges, a hedging loss of approximately 12%. This would certainly be painful if viewed in isolation, however, when viewed in total portfolio context, this period was actually very kind to plan sponsors as risky assets such as equities more than made up for the hedging loss in this period.

In addition, we see that across all time periods the spread durations of equities and high yield bonds were positive. This supports the idea that risky assets like equities and high yield bonds should not be ignored when setting a liability credit spread risk management strategy. However, it should also be noted that even though the data does support assuming positive spread duration for equities and high yield bonds, the wideness of the 90% confidence intervals tells us spread duration is not determinable with a high degree of certainty. In the case of equities, the spread duration has been consistently large and roughly in line with 10-15 year spread duration of most pension liabilities. Thus, for sponsors with the majority of asset allocated to equities, we can hypothesize that those equities would have offset the majority of liability credit returns and adding credit exposure to the liability hedging portfolio may have offered little in terms of reducing total portfolio risk relative to the liability.

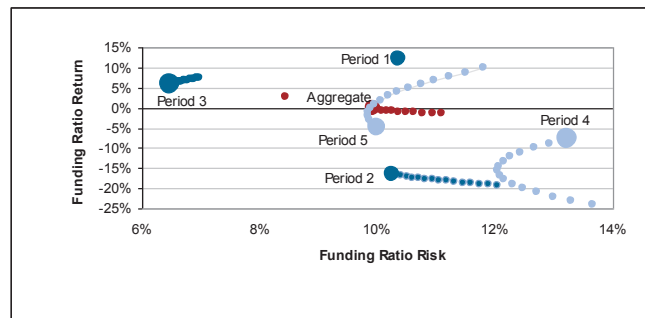
Focus on funding ratio

As suggested earlier, in order to achieve the best funding ratio outcomes, the construction of the liability hedging component of the portfolio must be integrated with the construction of the return generating component. This is true when focusing on any of the market-related liability risks, be it interest rate, credit, inflation or wage growth risk. Here we focus on the credit spread risk component of liability risk. In order to analyze liability credit risk in a total portfolio context, we evaluate the performance, across all four periods, of various approaches to credit risk management by focusing on what matters most – the plan's funding ratio.

We assume a pension fund which has an asset allocation of 65% equity and 35% liability hedging assets. To start, we assume the liability hedging assets are invested in cash plus interest rate swaps that hedge 75% of the liability's interest rate risk.⁴ While maintaining the 65% allocation to equities, we then evaluate the impact on the plan's funding ratio risk and return of adding credit risk to the liability hedging portfolio until we attain a 75% credit hedge. We do this by first moving the physical hedging assets from cash to the long duration corporate bond strategy we have been modeling throughout the paper. Then, once the 35% physical liability hedging assets are exhausted we assume that we can actually get synthetic exposure to long duration corporate bonds via a total return swap where the pension

fund pays LIBOR and receives the total return on the long duration corporate bond strategy. In the current environment, based on our knowledge, no investment bank today is willing to offer such a total return swap on a long duration corporate bond portfolio. However, we assume we can implement this hypothetical total return swap in order to analyze the potential impact of adding additional credit exposure beyond the fixed income allocation. Results for all time periods are summarized in Exhibit 6. Please note that each time period's starting point (0% credit hedge) is indicated on Exhibit 6 by large circles.

Exhibit 6: Impact of adding credit risk to the liability hedge



Sources: Legal & General Investment Management America, Bank of America Merrill Lynch, Bloomberg

Note: Funding ratio risk is the annualized standard deviation of monthly funding ratio returns. Funding ratio returns are equal to annualized monthly funding ratio returns. Monthly funding ratio returns calculated as $(\text{asset return} - \text{liability return}) / (1 + \text{liability return})$. Equity returns are equal to the return of the S&P 500 total return index. Returns of the long duration corporate bond strategy are equal to the returns of the Barclays Capital Long Credit (credit quality A or better) index. Cash returns are equal to LIBOR.

Liability returns are based on a duration neutral (relative to the corporate bond benchmark) blend of the Bank of America Merrill Lynch Young US Pension Plan AAA-A Liability index and the Bank of America Merrill Lynch Retired US Pension Plan AAA-A Liability index. Swap hedge returns are based on a duration neutral (relative to the liability benchmark) blend of the Bank of America Merrill Lynch Young US Pension Plan Swap Liability index and the Bank of America Merrill Lynch Retired US Pension Plan Swap Liability index minus LIBOR.

We notice that with the large allocation to equities, adding additional risk to the hedge portfolio in the form of credit risk only reduces funding ratio risk meaningfully during the 2007-2008 credit crisis (period 4). This may be surprising given that, in isolation, corporate bonds had a lower tracking error relative to liability returns than interest rate swaps. This finding supports our hypothesis above; for plans invested 65% in equities, adding credit risk to the hedging portfolio offers little in terms of reducing funding ratio volatility as the equities had enough spread duration to offset the vast majority of liability credit spread risk.

Although for period 4 modest levels of credit spread hedging reduced funding ratio volatility, the funding ratio outcome was, as expected, much worse for all levels of credit spread hedging. In general, we notice that during times of economic stress, adding credit will make painful periods more painful and good periods even better (i.e., periods 3 and 5). Further,

at very high levels of credit hedging, credit exposure exacerbated the bad outcomes during bad periods and good outcomes during good periods.

Most importantly, regardless of the size and composition of the risky asset portfolio, adding credit risk to the liability hedge only leads to better funding ratio outcomes during good economic periods where credit spreads are narrowing and leads to significantly worse outcomes when sponsors can tolerate it the least – during periods of economic stress. Thus, we recommend that, from a long-term policy perspective where we assume a world where credit spreads are fairly valued and not expected to narrow, plan sponsors should avoid large allocations to credit risk in the liability hedge. However, we also recommend, from a tactical perspective, when credit spreads are deemed wide and are expected to narrow, to add credit risk to the liability hedge in order to improve funding ratio outcomes.

Tactical Considerations

Essentially, regardless of the size and composition of the risky asset portfolio, adding credit risk to the liability hedge before spreads narrow and removing credit from the liability hedge before credit spreads widen will improve funding ratio outcomes. Early 2009 is a good example of a market environment when consideration should have been given to tactically adding credit to the liability hedge. As of March 31, 2009 a corporate bond-based discount rate was approximately 380bps higher than an interest rate swap-based discount rate. This is extremely large relative to the historical average of 100bps for the aggregate time period we have been analyzing. During more normal economic periods when the discount rate spread is around the historical average of 100bps, credit spreads can only narrow so much and therefore the potential hedging loss on a swap-based hedge can only be so large. Therefore, when spreads are normal and not expected to narrow, credit risk in the liability hedge should be reduced to long-term policy levels in order to better protect the plan's funding ratio for the next economically stressful period.

However, with pension discount spreads at 380bps, sponsors with swap- or Treasury-based hedges may experience a significant drop in funding ratio if credit spreads narrow significantly. For example, for the typical liability profile we have analyzed in this article, all else equal, liability discount spreads narrowing 280bps back to the historical average would result in a liability credit spread return of 45%. So, for plan sponsors concerned about the impact of spreads narrowing and large liability credit spread returns, how much credit risk should be added to the liability hedge in order to mitigate the damage?

Consistent with the above, it is our view that this decision must be made in a total portfolio context and is therefore dependent on the size and composition of the risky asset portfolio. First, let's assume there is no risky asset portfolio and the sponsor is trying to immunize the plan's funded ratio. Consistent with the level of conviction there is that spreads will narrow, a commensurate amount of the asset portfolio should incorporate a liability credit spread hedge. If there is absolute conviction that spreads will narrow then 100% of the asset portfolio should include a liability credit spread

hedge. However, what should a plan sponsor with only 35% of assets allocated to liability hedging and 65% allocated to equities do? In this case, expected spread duration of equities must be factored into the decision of how much credit risk to add to the liability hedge. Based on the spread duration statistics discussed in Exhibit 5, we believe it is reasonable to assume that equities have a spread duration roughly equal to that of most pension liabilities; approximately 10 years. Using this assumption, we would limit the amount of assets allocated to liability credit hedging to the size of the liability hedging portfolio. In other words, depending on the level of conviction that spreads will narrow, we would allocate a commensurate proportion of the 35% liability hedging assets to liability credit hedging assets and assume the other 65% of liability credit returns are offset by the spread duration of equities. Of course, as previously discussed, it must be understood that spread duration of equities is not known with certainty and that it may be smaller or larger than assumed.

It's clear that sponsors face potentially bad funding ratio outcomes if credit spreads narrow. And, for those with little or no allocation to risky assets, the credit spread narrowing scenario is even scarier as they have fewer risky assets to help offset large liability credit spread returns. Therefore, when credit spreads are deemed extremely wide and likely to narrow, we recommend integrating, on a tactical basis, credit risk as part of the liability hedging component to mitigate the funding ratio damage that may occur in a narrowing credit spread scenario. The amount of credit risk to add is a function of the size and composition of the risky asset portfolio as well as the level of conviction there is that credit spreads will narrow. However, as mentioned earlier, plan sponsors must be aware of the risks that come with adding credit exposure to liability hedging assets. If credit spreads continue to widen, defaults and downgrades increase, and equities perform poorly, the larger and weaker the credit risk in the hedging portfolio, the more painful the funding ratio outcome will be.

For those that decide to tactically add credit risk, it is imperative that plan sponsors have a strategy in place to reduce overall credit risk to policy levels as credit spreads narrow to normal levels. By doing so, as conditions return to normal and credit risk is reduced, we believe plan sponsors will be better protected for the next economic downturn.

Conclusion

Whereas managing liability interest rate risk via interest rate swaps and/or Treasuries is relatively straightforward, managing liability credit spread risk is more challenging for three important reasons: (1) liability credit spread returns are not investable as corporate bonds are subject to default risk while liability returns are not, (2) there is no capital-efficient risk management tool as synthetic exposure to CDX has been an ineffective hedge of liability credit risk, and (3) there is a stable connection between liability credit spread returns and the returns of risky assets – especially during periods of economic stress when risky return generating assets fall and credit spreads widen. Therefore, in order to construct efficient LDI solutions and avoid poor funding ratio outcomes, it is essential to view the liability credit spread risk from a



total portfolio perspective inclusive of the “risky” asset component of an LDI solution.

As a general rule, from a long-term policy perspective, the larger and more equity-like the composition of the risky asset portfolio, the less plan sponsors should utilize credit risk in the liability hedge. For sponsors looking to immunize or have little invested in risky assets, adding credit would have significantly increased the effectiveness of the liability hedge. However, this reduction of tracking error comes with a cost – exposure to bad funding ratio outcomes during periods of economic stress. For sponsors with large allocations to risky assets, adding credit to the liability hedge offers little in terms

of funding ratio risk reduction and exacerbates the bad funding ratio outcomes during periods of economic stress as risky assets perform poorly while, at the same time, the liability hedge underperforms.

However, from a tactical perspective, funding ratio outcomes can be improved by tactically managing the credit profile of the liability hedge - adding credit to the liability hedge when there is conviction that credit spreads will narrow and removing credit as credit spreads narrow back to normal levels. Importantly, when adding credit, the amount of credit risk taken must be scaled appropriately in a total portfolio context.

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¹ For most pension plans, the biggest component of liability risk is the impact of the discount rate changing. However, changes in the expected benefits themselves as well as liability "noise" will also cause volatility in the liability. See Meder and Staub [2006], Bookstaber and Gold [1988], Ezra [1991], and Leibowitz, Kogelman, and Bader [1991] for details.

² It is debatable whether the interest rate swap curve is credit risk-free. However, there are two big differences between corporate bonds and interest rate swaps which allow us to assume interest rate swaps have little credit risk. First, unlike a corporate bond where principal is at risk until maturity, swaps only exchange interest payments. Second, any mark-to-market gain on a swap position is collateralized within a few days with Treasuries by the counterparty.

³ For example, for the 2000-2002 period, the aggregate default rate for A rated bonds was 0.3% versus 1.8% for BBB rated bonds. See Moody's [2008] for details.

⁴ In general, for sponsors with large allocations to equities, hedging liabilities beyond 70%-80% offers little incremental risk reduction benefits and can expose the fund to large collateral calls during rising interest rate environments.

