Pension Solutions' Insights

Level 2 LDI: Three key implementation considerations

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Executive Summary

We define Level 2 LDI implementation as implementation done with an explicit liability benchmark and, often times, with the use of derivatives. We find that successful Level 2 LDI implementation is dependent on effectively determining (1) the appropriate levels of interest rate and credit spread hedging, (2) if the efficiencies gained via Level 2 LDI exceed the costs that come with it, and (3) if derivatives are needed, if synthetic equities or synthetic liabilities should be used to implement the desired exposures.

Consistent with our Level 1 LDI research, we find that to construct efficient LDI solutions and avoid poor funding ratio outcomes, it is essential to view these considerations from a total portfolio perspective. We also find that the answers to these questions change as the plan sponsor de-risks the plan by moving assets from a Return-Seeking Asset (RSA) component to a Liability-Hedging Asset (LHA) component. More specifically we make the following three key observations which are summarized in the table below.

First, we find that, strategically, the vast majority of interest rate risk should be hedged. We find this to be true even when there is a very large exposure to an RSA component. Further, we find that the strategic credit spread hedge ratio is dependent on the size and composition of the RSA component. The bigger and more equity-like the RSA component, the lower the strategic credit spread hedge ratio should be.

Second, we find that the risk reduction benefits and the importance of using a liability benchmark are significant, likely outweigh the costs, but are dependent on several factors – liability profile, funded status, and size of the RSA component. Importantly, the incremental improvement to funding ratios are especially large when they are needed the most - during periods of economic stress.

Third, using synthetic equities to free up capital to hedge with a physical corporate bond portfolio can increase the effectiveness of the credit spread hedge and may add to portfolio yield. Importantly, these benefits are only relevant for plan sponsors who desire a target credit spread hedge ratio beyond what can be achieved without freeing up more capital by synthesizing at least part of the RSA component.

Summary of key Level 2 LDI implementation considerations:

Equity Exposure	60%	40%	20%
Target Hedge Ratios			
Interest Rate	80%	90%	100%
Credit Spread	10%	30%	50%*
Benefits of Level 2 LDI (Relative to Long Government / Credit)			
Volatility Reduction (Mature Plan)	-15%	-15%	-14%
Volatility Reduction (Average Plan)	-25%	-29%	-37%
Funding Ratio Improvement During Period of Stress (2000-2002 Recession)	8%	6%	5%
Importance of a Liability Benchmark for the LHA component	High	Higher	Highest
Benefits of Synthetic Equities			
Risk Mitigation	Smaller	Small	Moderate
Yield Enhancement**	Significant	Significant	Significant

*Particularly for frozen pension plans, other factors such as how close the plan is to ultimate funding target needs to be taken into account and may drive the appropriate strategic credit spread hedge ratio down considerably

**Here we assume there is only a moderate amount of alpha forgone when selling physical equities and a similar cost of funding for both synthetic equities and synthetic liabilities

Level 2 LDI: Introduction

Liability Driven Investing (LDI) has emerged as best practice for corporate defined benefit plan sponsors. While the actual implementation of each plan sponsor's LDI strategy varies considerably, there is one consistent implication for how these plan sponsors approach asset allocation. The first order asset allocation decision is no longer focused on the split between equities and core fixed income but rather is focused on deriving the split between a Return-Seeking Asset (RSA) and a Liability-Hedging Asset (LHA) component. The RSA component seeks to generate returns in excess of the expected liability return (growth in the present value of the liability attributable to the passage of time – similar to the discount rate on the liability). The LHA component is focused on risk reduction by hedging risks in the liability that the sponsor does not wish to accept (i.e., interest rate risk and credit spread risk) and typically consists of long duration bonds, and, less frequently today, interest rate derivatives.

In our experience, transitioning from the traditional "60/40" (60% equities/40% core fixed income) policy to an LDI policy is typically done in phases. In the first phase liabilities are implicitly recognized as an important investment consideration which results in the core fixed income allocation being recognized as an inefficient use of capital. This is because core fixed income is ineffective at both hedging liabilities (duration is too short) and seeking returns in excess of liabilities (yield is too low). Therefore the first phase simply constructs the LHA component by switching the fixed income benchmark to a market-oriented long duration benchmark and does not typically need to utilize derivatives. We refer to this first phase as Level 1 LDI and discussed our thoughts on how best to set Level 1 LDI benchmarks in our previous white paper (Meder 2011).

The second phase of LDI implementation results in the plan's liabilities being the ultimate plan level investment benchmark and focuses resources on taking only compensated risk relative to this explicit liability benchmark. Also, this typically results in using a custom liability benchmark (scaled to reflect the target interest rate hedge ratio, credit spread hedge ratio, and amount of capital allocated to the LHA component) for the LHA component. We refer to this second phase of LDI implementation as Level 2 LDI. Efficient implementation of Level 2 LDI typically requires plan sponsors to embrace derivatives and explicitly state target levels of the key risks that drive funding ratio volatility - equity market risk, interest rate risk, and credit spread risk.

Our view on the appropriate implementation of Level 2 LDI is the focus of this paper. Based on our experience working with plan sponsors we can distil the major Level 2 implementation consideration into three key questions, (1) what are the appropriate levels of interest rate and credit spread hedging within the LHA component, (2) when do the benefits outweigh the costs of moving from Level 1 LDI to Level 2 LDI, and (3) should synthetic equities or synthetic liabilities be used to implement the desired set of derivatives exposures, if derivatives are needed? One of the main points of this paper is that the answers to these questions are dependent on the size and composition of the RSA component and therefore these questions need to be viewed from a total portfolio perspective. Consistent with this, as we discuss each issue in turn, we address how the answers to these questions may change as a plan de-risks by reducing the allocation to the RSA component and increasing the allocation to the LHA component.

Throughout the article, as a means of providing quantitative support for our conclusions, we utilize a funding ratio risk and return framework for measuring portfolio efficiency. This framework and similar liability-relative frameworks are not new and are well established in literature. Examples include Treynor (1976), Arnott and Bernstein (1988), Bookstaber and Gold (1988), Leibowitz et al. (1991), Ryan and Fabozzi (2002), and Waring (2004). In addition, it should be noted that, within this framework, the liability return series we use is based on a corporate bond-based discount rate as opposed to using a risk-free Treasury-based discount rate. This should not be taken as an endorsement for including a credit spread in pension discount rates. 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 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 this article should be viewed as a guide for how best to construct Level 2 LDI solutions for plan sponsors who choose to incorporate it.

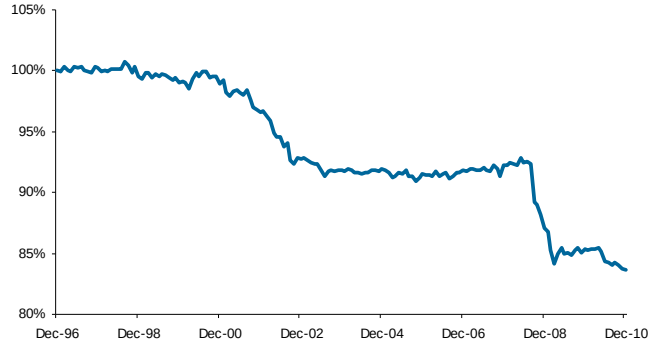
Understanding Pension Liability Discount Rate Risk

We start with an in-depth discussion of pension liability discount rate risk. The biggest year-to-year liability risk plan sponsors face is the pension discount rate falling, causing an increase in the present value of the pension liabilities. Importantly, pension discount rate risk can be caused by two different market scenarios (1) Treasury rates falling and/or (2) A-AAA credit spreads narrowing. We refer to the former as interest rate risk and the latter as credit spread risk. Each of these risks needs to be explicitly managed.

While interest rate risk can be managed in a relatively straightforward manner, it is crucial to realize that credit spread risk is not so straightforward to manage (see Meder 2008 for details). This is because while credit spread risk is very real and can have very real economic consequences, pension liabilities do not actually have default risk. In other words, if you buy credit to manage this credit spread risk you are exposed to real losses on your assets when a bond defaults or is downgraded, whereas you do not have an offsetting benefit (default) in your liabilities by paying less in benefit payments.

This issue is most easily seen by tracking a plan's funding ratio over time where the plan was invested in long duration credit (A or better credit quality) that matched the duration of the plan's liability. Figure 1 tracks the funding ratio of this hypothetical plan and immunization strategy.

Figure 1: Historical funding ratio performance for a long credit immunization strategy



Source: Bloomberg, Bank of America Merrill Lynch, and Barclays

Note: Asset returns are based on the Barclays US Long Credit A-AAA Index. Liability returns are based on a duration neutral (relative to the asset benchmark) blend of the Merrill Lynch Retired US Pension Plan AAA-A Index and the Merrill Lynch Young US Pension Plan AAA-A Index.

Clearly, the long credit immunization strategy is not risk-free. The strategy has significantly underperformed the liability since December 31, 1996. Importantly, most of the underperformance occurs during periods of economic stress when the RSA component (i.e. equities) of the portfolio is struggling and corporate cash flow is weak. Essentially, investing in long duration credit exacerbates the funding ratio pain when plan sponsors can tolerate it the least.

However, this does not mean that one should always avoid credit and invest in Treasuries but rather, in our view, has the following four key implications for pension risk management:

- From a long-term policy perspective, the larger and the more equity-like the composition of the risky asset portfolio, the less credit heavy and the more Treasury-like the LHA component should be. During previous periods of economic stress, equities and other risky return generation assets have typically fallen and credit spreads have widened. Therefore, the credit profile of the risky asset component of the overall portfolio needs to be taken into account when deciding on the strategic (neutral) level of long duration credit within the LHA component.

- From a tactical perspective, as spreads change credit risk can be dynamically managed to improve funding ratio outcomes. For example, you may opportunistically increase credit risk when spreads are wide and you believe they will narrow. Alternatively, if spreads are narrow and there is little risk of further narrowing, reduce credit allocations and be less exposed to the next economic downturn.

- When investing in credit one should consider a "liability aware" long credit strategy that is risk-focused with the objective of avoiding downgrades and defaults and minimizing drag relative to the liability. This is especially true as the LHA allocation increases and the desired precision of the liability match increases as well.

- For frozen plans that are contemplating their "end game" strategy, consider defining the ultimate funding target as something close to 100% funding on a Treasury basis. At this level of funding the plan can fully remove investment risk (other than Treasury default risk) and is likely also fully funded on an annuity buyout basis.

Key Considerations for Level 2 LDI Implementation

With pension liability interest rate and credit spread risk understood, we can turn our attention to the three key considerations relevant to Level 2 LDI implementation.

1. What is the appropriate benchmark for the LHA component?

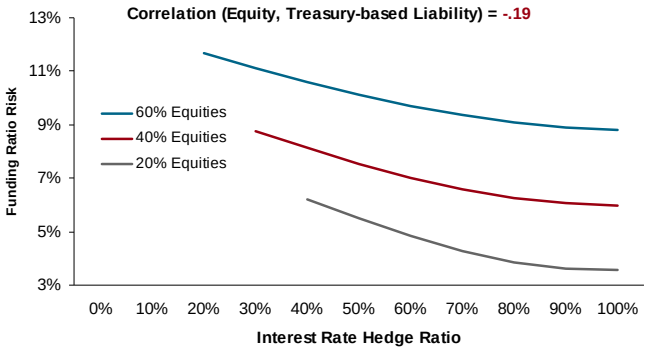
There are two critical decisions that need to be made when constructing the benchmark for the LHA component of a Level 2 LDI solution. First, how much of the liability interest rate risk should be hedged - in other words, what is the strategic interest rate hedge ratio? Second, determining how much of the liability credit spread risk should be hedged – we refer to this as the strategic credit spread hedge ratio.

Strategic Interest Rate Hedge Ratio

We start with the strategic interest rate hedge ratio. In our experience we found that this decision is mostly driven by a combination of (1) what the risk reduction benefits are of increasing the interest rate hedge ratio, and (2) the level of liquidity risk introduced as derivatives are increasingly needed when increasing the interest rate hedge ratio.

Looking first at the benefits of interest rate hedging, we measured the historical funding ratio risk of various interest rate hedge ratios. We tested this for plan sponsors with a 60%, 40%, and 20% allocation to equities to give an indication of how the appropriate interest rate hedge might change as plan sponsors de-risk. At this point we simply assume that half of the physical assets held within the LHA component is allocated to long duration corporate bonds. The other half is allocated to cash and a Treasury-based hedge used to attain the various levels of interest rate hedging. When determining the interest rate hedge ratio we assign zero duration to the equities. The historical time-series we analyzed was the period from December 31, 1996 until December 31, 2010. The results of the historical back test are summarized below in Figure 2.

Figure 2: Historical funding ratio risk for various interest rate hedge ratios – aggregate period



Source: Bloomberg, Bank of America Merrill Lynch, and Barclays

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 (asset return – liability return) / (1+ 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. Treasury-based interest rate 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 Treasury Liability Index and the Bank of America Merrill Lynch Retired US Pension Plan Treasury Liability Index minus LIBOR.

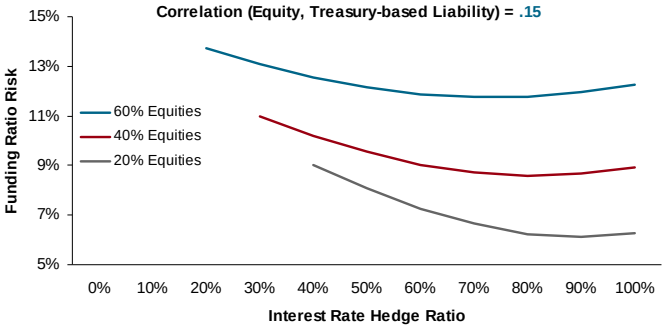
The graph shows that, for all equity levels, risk is reduced by increasing the interest rate hedge ratio. This is not a surprising result as increasing the interest rate hedge ratio reduces the duration mismatch between assets and liabilities and therefore reduces the impact that changes in interest rates can have on the plan's funding ratio. It is worth noting that there are diminishing amounts of risk reduction as the interest rate hedge ratio increases. This is because equity volatility increasingly dominates the overall funding ratio risk as interest rate risk is reduced. Said differently, as the level of interest rate hedging approaches the "optimal" point the remaining interest rate risk is almost completely diversified away by the remaining and dominant equity exposure. Therefore, the last few incremental amounts of hedging offer little additional risk reduction.

Further, and consistent with the above, the overall risk reduction benefits of interest rate hedging increase as the equity exposure is reduced. With 60% equities, the benefit of going from 20% interest rate hedged to 100% interest rate hedged is a 25% reduction in risk. With 20% equities, the benefit of going from 40% interest rate hedged to 100% interest rate hedged is a 43% reduction in risk. What can be seen here is that a large (i.e. 60%) exposure to equities can overwhelm interest rate risk and therefore limits the benefits of increasing the interest rate hedge ratio and removing the interest rate risk.

Another consideration is how the risk reduction benefits of interest rate hedging can change depending on the market environment. Based on our research the biggest market factor that can impact the optimal interest rate hedge ratio is the correlation between the RSA component and the interest rate risk in the liability. During the aggregate period this correlation was -0.19. Mathematically, this negative correlation is equivalent to assigning equities a negative duration. This negative duration is precisely why you notice in Figure 2 that risk is reduced all they way up to a 100% interest rate hedge ratio.

However, there are periods of time when this correlation is positive and it is important to consider what impact this can have on the risk reducing benefits of interest rate hedging. Figure 3 summarizes the benefits of hedging for a subperiod (July 1, 2007 through March 31, 2009) where the correlation was a positive 0.15.

Figure 3: Historical funding ratio risk for various interest rate hedge ratios – positive stock-bond correlation



Source: Bloomberg, Bank of America Merrill Lynch, and Barclays

This positive correlation simply means that over this subperiod equities exhibited (small) positive interest rate duration and thus hedged a (small) portion of the interest rate risk in the liability. This is why in Figure 3 we see that risk is minimized prior to achieving a 100% interest rate hedge. For example, with 60% equities, risk is minimized at an interest rate hedge ratio of 75%. Essentially, the positive correlation between equities and the interest rate risk in the liabilities offsets the remaining 25% of the risk and so hedging beyond 75% actually reintroduces interest rate risk. This issue is not as impactful for plans with a small allocation to equities. Essentially, the smaller the equity exposure the more certainty there is with respect to the optimal interest rate hedge. Therefore, we typically recommend targeting a higher interest rate hedge ratio when having a smaller amount of equity exposure. However, we still typically recommend a fairly large interest rate hedge ratio even for plans with a large equity exposure. This is partly due to the fact that equities tend to exhibit negative duration during periods of economic stress. In other words, when interest rates are falling during a flight-to-quality economic environment and driving liability values up, equities are falling and actually exacerbating the funding ratio pain.

So we urge caution when considering assigning equities any positive contribution to duration. Given all of these risk reduction considerations, for this particular situation, we would recommend 80%, 90%, and 100% interest rate hedge ratios for 60%, 40%, and 20% equity exposures respectively.

The last issue to consider is whether or not these target hedge ratios are practical to implement. By practical we mean, if a plan holds 60% equities can we really hedge 80% of its interest rate risk without exposing the plan to too much derivatives-related liquidity risk. The risk that our clients worry about is that interest rates rise causing mark-to-market losses on the interest rate derivatives used to implement the hedge. These mark-to-market losses need to be collateralized on a daily basis so there needs to be sufficient collateral set aside to meet these collateral requirements.

To address this concern we use a stress test in order to determine what the collateral requirements might be during stressful scenarios. Here we focus on the plan with 60% equities and a target 80% interest rate hedge. If we can get comfortable with this situation we should be able to get comfortable with our recommended interest rate hedge ratios for the plans with 40% or 20% exposure to equities. Figure 4 summarizes the results of our stress test on a hypothetical plan with $100 in assets and liabilities, a 60% equity allocation, and an 80% target interest rate hedge. The 80% target interest rate hedge is implemented with a $20 investment in long duration corporate bonds and $20 in cash which backs up a $60 notional exposure to Treasury-based interest rate derivatives.

Figure 4: Impact of stress test on assets and liabilities

		Rates + 200bps		Rates + 200bps, Equities -30%	
	Baseline	Post-shock	Post-rebalance	Post-shock	Post-rebalance
LHA Component					
Long Credit	20	16	16	16	16
Cash	20	20	29	20	21
Treasury Derivatives (60 Notional)	0	(11)	(11)	(11)	(11)
Total	40	26	34	26	27
RSA Component					
Equities	60	60	51	42	41
Total Assets	100	86	86	68	68
Total Liabilities	100	82	82	82	82
Funded Status	0	4	4	(14)	(14)
Funding Ratio	100%	104%	104%	82%	82%
Equity Allocation (%)	60%	70%	60%	62%	60%

Source: Legal & General Investment Management America

Note: Liabilities are assumed to have a duration of 11 years and a convexity of 1.

We can see what happens to all assets, liabilities, funded status, funding ratio, and asset allocation for two types of shocks. First, we simply shock interest rates by an increase of 200 basis points and assume that the value of the RSA component of assets remains unchanged. We also make the simplifying assumption that credit spreads remain stable. This 200 basis points rise in rates is a 99th percentile outcome looking at rate increases over rolling three month periods based on the last 30 years of data. Looking at the first three columns in Figure 4 we can make the following key observations:

- Since interest rates have risen, both assets and liabilities drop in value. Importantly, the liabilities drop more than the assets since we have only hedged 80% of interest rate risk and so the funded status and funding ratio of the plan actually increases.

- There is mark-to-market loss on the interest rate derivatives of -$11 which eats through about half of the $20 in cash collateral that was set aside to post against these mark-to-market losses.

- Because the LHA component decreases so much in value the plan's allocation to equities increases from 60% of assets to 70% of assets. This would likely trigger a rebalance out of the RSA component and into the LHA component.

- If the plan rebalances to a 60% allocation to equities, $9 is reallocated from the RSA component into the LHA component. This re-establishes a reasonable amount of net collateral backing up the interest rate derivatives in case of further potential mark-to-market losses.

Overall, this scenario is not a manageable outcome for plan sponsors from a derivatives risk management perspective. What can be a more difficult outcome to deal with is the scenario where interest rates rise and equity markets fall. Looking at the last two columns in Figure 4, we can see that the only difference is driven by equity markets falling 30%. This 30% drop in equity markets is a 99th percentile outcome looking at historical equity market volatility over rolling three month periods based on the last 30 years of data. This drop in equity markets results in a lower value of assets, funded status, and funding ratio when compared to just a shock in interest rates. The plan still ends up with an RSA exposure of 62% so should consider rebalancing. If the plan were to rebalance back to 60%, $1 would need to be reallocated from the RSA component to the LHA component. In order to maintain a 20% allocation to long duration corporate bonds an additional $3 could be allocated to cash. Please note that both selling equities and corporate bonds in this scenario carries a certain amount of regret risk if the RSA component and corporate bonds rally in a market recovery.

While this is not an ideal scenario for any pension manager it is a manageable situation. Further, it should be acknowledged that this scenario of large rises in interest rates coupled with a large drop in equity markets has been uncommon. Lastly, this scenario needs to be weighed against the considerable amount of funding ratio protection received during an economic stress scenario where interest rates and equity markets fall significantly. We examine the amount of protection received with a Level 2 LDI solution during this more common economic stress scenario in the next section. Overall, in this case, we are comfortable that our recommended hedge ratios are both appropriate from a risk mitigation perspective and from a practical implementation perspective.

Lastly, it is worth considering how a plan's funded status and liability profile may impact the practicality of these recommended interest rate hedge ratios. All else equal, the higher the plan's funding ratio the more assets there are to hedge the liability and therefore the easier it is managing the derivatives-related liquidity risk. With respect to the plan's liability profile, assuming all else equal, the longer the plan's liability duration the more volatility the hedging portfolio will have and therefore the more difficult time managing the derivatives-related liquidity risk. So, for underfunded plans with longer than average liability profiles these practical implementation considerations can result in significantly lower recommended interest rate hedge ratios.

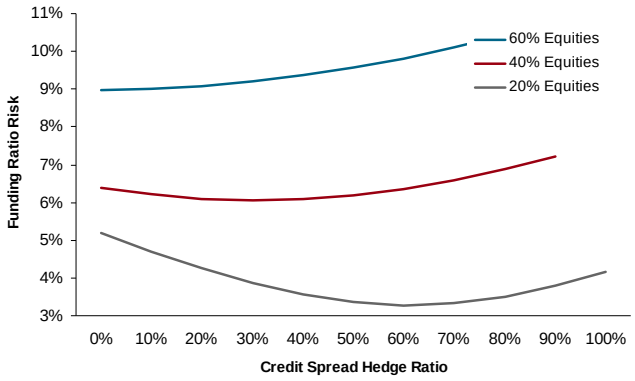
With this being said we acknowledge that many market participants believe interest rates are going up and may find it uncomfortable to consider such high interest rate hedge ratios. However, we must stress again how important it is to separate tactical views from strategic benchmarking decisions. The strategic benchmark decision should be based on long-term expectations for risk and return. If one has a view that rates will rise then this can be reflected by implementing a lower interest rate hedge ratio but this should be acknowledged as an active bet versus the strategic benchmark.

Strategic Credit Spread Hedge Ratio

We can now turn our attention to the second important benchmarking decision – what should the target credit spread hedge ratio be. As mentioned above and in our Level 1 LDI paper this decision is highly influenced by the size and composition of the RSA component.

Below we summarize our research and recommendations on this topic (for additional details please see Meder 2009). In order to analyze this we follow a similar approach to analyzing the impact of interest rate hedging - we measure the historical funding ratio risk of various credit spread hedge ratios. We tested this for plan sponsors with a 60%, 40%, and 20% allocation to equities to give an indication of how the appropriate level of credit spread hedging might change as plan sponsors de-risk. We assume that the overall target interest rate hedge ratio is static as we increase the level of credit spread hedging. For 60%, 40%, and 20% equities, we assume 80%, 90%, and 100% static target interest rate hedge ratios. While maintaining the respective allocation to equities, we then evaluate the impact on the plan's funding ratio risk of increasing the credit spread hedge until we attain a credit spread hedge equal to the respective static target interest rate hedge ratio. 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 physical assets held within the LHA component 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 LHA capital allocation. When determining the credit spread hedge ratio we assign zero duration to the equities. The historical time-series we analyzed was for the period from December 31, 1996 until December 31, 2010. The results of the historical back test are summarized below in Figure 5.

Figure 5: Historical funding ratio risk for various credit spread hedge ratios – aggregate period



Source: Bloomberg, Bank of America Merrill Lynch, and Barclays

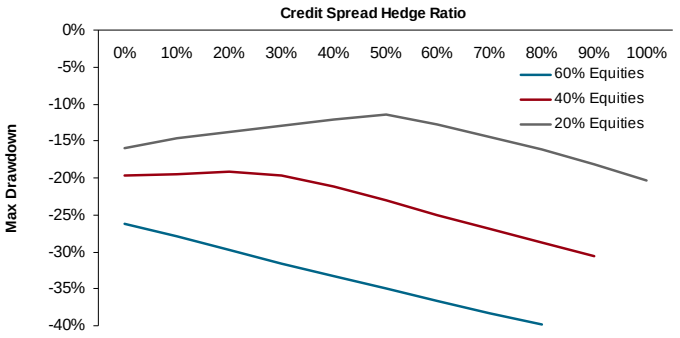
With 60% equities, very small increases in the credit spread hedge ratio increase overall funding ratio risk. This is because the large allocation to equities has been highly correlated with the credit spread risk in pension liabilities and has therefore offset the liability volatility associated with credit spread movements. The first 20% increase in the credit spread hedge ratio has little impact on risk. After that point, further increases to credit, increase risk on an accelerated basis.

With 40% equities, risk is reduced up to the point when the credit spread hedge ratio approaches 30%. As the credit spread hedge ratio increases beyond 30% risk begins to increase. This is because, and following the same logic as above, a 30% credit spread hedge ratio combined with a 40% equity allocation has essentially offset the liability volatility associated with credit spread movements.

With 20% equities, risk is minimized with a credit spread hedge ratio of 50%. Since there was not much equity exposure to offset the liability volatility associated with credit spread movements, a large allocation to credit is necessary to minimize risk.

In addition to looking at funding ratio volatility over the past 14 years, it is also important to analyze risk during periods of economic stress. It is during these difficult economic periods that the LHA component needs to help buoy funded status and not make things worse. For this we analyzed historical maximum funding ratio drawdowns during the most recent credit crunch (July 1, 2007 to March 31, 2009) for various credit spread hedge ratios. Figure 6 summarizes the results.

Figure 6: Historical maximum funding ratio drawdown for various credit spread hedge ratios

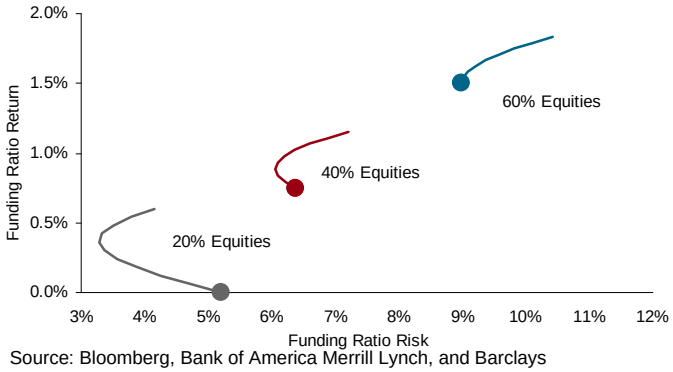


Source: Bloomberg, Bank of America Merrill Lynch, and Barclays

Figure 6 adds further support to our key findings above. Just as too much credit can increase funding ratio risk; it can also exacerbate the funding ratio pain during the worst possible times. This is especially true for sponsors with large allocations to equities. With 60% equities the maximum funding ratio drawdown increased by almost 15 percentage points as the credit spread hedge ratio increases from 0% to 80%. For sponsors with a 20% allocation to equities having a 50% credit spread hedge ratio would have helped reduce the maximum funding ratio drawdown by approximately 5% during these difficult economic periods. However, increasing the credit spread hedge ratio from 50% to 100% would have worsened the funding ratio drawdown by almost 10%. At this point we can safely say this credit spread hedge ratio decision is an important one and appears to be highly dependent on the size and composition of the RSA component.

However, we have only considered the implication for funding ratio risk so far. We also need to consider the potential long-term excess returns credit may provide over Treasuries. Essentially, we need to analyze the impact of investing in credit versus Treasuries on funding ratio risk and funding ratio return. In order to measure the impact on funding ratio return we make assumptions for the long term returns of liabilities, long duration credit, long duration Treasuries, and equities (see Appendix for details). Based on these return assumptions along with the historical volatilities we have discussed we can now analyze the risk-reward tradeoff of increasing the credit spread hedge. Figure 7 summarizes the results of this risk-reward tradeoff.

Figure 7: Risk-reward tradeoff for various levels of credit spread hedging



Source: Bloomberg, Bank of America Merrill Lynch, and Barclays

The large circle represents the risk-reward for a credit spread hedge ratio of 0% credit and the target interest rate hedge ratio that we have been modeling throughout this section. The line reflects the path the risk-reward tradeoff takes as we increase the credit spread hedge ratio. Return increases as we move assets from a Treasury-based hedge to a credit-based hedge which is assumed to provide an excess return over the long-term. However, as discussed above, risk also increases as the credit spread hedge ratio increases beyond what was needed (in addition to the equity portfolio) to offset the impact of changing credit spreads on the liability.

Where on these risk-reward curves is the most appropriate place to be? In the case of a 20% or a 40% allocation to equities, there are clearly some inefficient choices – those at the bottom of the curve which offer a lower expected return (relative to the top of the curve) for a given level of risk. The efficient part of these curves spans from the minimum risk portfolio to the maximum return portfolio. In our view, the primary objective of LHA component is to reduce funding ratio risk and therefore we recommend anchoring the strategic credit spread hedge to the minimum risk portfolio.

For plan sponsors with high equity allocations this minimum risk portfolio will have a relatively low credit spread hedge ratio and may cause concern for plan sponsors who are counting on large allocations to credit in order to hit a particular long-term return target. For these plan sponsors we suggest revisiting the size and composition of the RSA component (as opposed the split between credit and Treasuries) as this tends to be a more efficient lever to pull in order to achieve a certain target return.

However, there are other qualitative factors that must be considered before making this strategic benchmark decision. For example, assume a plan sponsor has reduced equities to 20% because the plan is frozen and is well funded and approaching its ultimate funding target of fully funded on a Treasury or annuity buyout basis.

When this plan sponsor hits this funding target we would recommend removing investment risk from the plan by investing 100% in duration matched Treasuries. Given this set of circumstances, we would caution this plan sponsor from setting a credit spread hedge ratio as high as 60% and recommend something significantly lower.

Lastly, we cannot overemphasize that this discussion revolves around the long-term strategic credit spread hedge ratio. This decision should be based on long-term expectations of risk and return and should be separate from tactical views based on the relative value (i.e. views on credit spreads) of credit vs. Treasuries. With that being said, we recognize that there are periods of time when credit spreads are very wide (i.e. early 2009) or very narrow (i.e. early 2007). And, as stated at the beginning of this paper, we fully support the use of significant discretion (i.e. +/- 15%) around the strategic (neutral) credit spread hedge ratio to take advantage of these environments and better control funding ratio outcomes.

In summary, we find that the appropriate long-term credit spread hedge ratio is highly dependent on the size and composition of the RSA component of the overall portfolio and the long term objectives of the plan sponsor. Based on a typical liability profile and the various risk and return assumptions we have made, we find that a credit spread hedge ratio anywhere from 10% (60% equities) to 50% (20% equities) may be appropriate.

2. Is it worth it to move from Level 1 LDI to Level 2 LDI?

After discussing what the appropriate level of interest rate and credit spread hedging are for a particular plan, we often get the same follow-up question – Is it worth introducing the complexity and costs of utilizing a liability benchmark and the derivatives that may come along with a Level 2 LDI solution? This is a fair question that deserves attention. We start by analyzing the risk and return implications of moving from Level 1 LDI to Level 2 LDI. While we see a wide variety of Level 1 LDI solutions we make the simplifying assumption for this analysis by modeling the Level 1 LHA as if it was passively invested in the Barclays Long Government / Credit Index. We utilize the same time series we have been using throughout this article. Figure 8 summarizes the key funding ratio statistics for comparing Level 1 vs. Level 2 LDI approaches for various levels of equity exposure.

Figure 8: Benefits of Level 2 LDI – mature liability profile

	LHA Component			Improvement in Funding Ratio (Level 2 vs. Long Gov't / Credit)	
Equity Allocation	Long Gov't / Credit	Level 2	Risk Reduction	4/1/2000 - 9/30/2002	7/1/2007 - 3/31/2009
60	10.7%	9.0%	-15%	8%	10%
40	7.1%	6.1%	-15%	6%	6%
20	3.9%	3.4%	-14%	5%	2%

Source: Bloomberg, Bank of America Merrill Lynch, and Barclays

We see that, for all levels of equity exposure, an approximate 15% reduction in funding ratio risk has been achieved by moving to a Level 2 LDI solution. While this is not an obviously large number it is a meaningful reduction in volatility. Further, in our experience, Level 2 LDI adopters also focus their attention on how well a particular strategy holds up during periods of economic stress. In these scenarios we have seen significant benefits that have come with a Level 2 LDI solution as can be seen in the last two columns of Figure 8. For example, with 60% equity exposure, this particular plan's funding ratio would have been improved by 8% and 10% during the 2000-2002 recession and the 2007-2009 credit crunch respectively. The risk reduction benefits are less significant as the equity allocation is reduced. This is because, as the equity allocation is reduced, the credit spread hedge increases more in the Level 2 LDI solution which dampens the benefits as credit performed poorly during these economic stress periods, especially during the 2007-2009 credit crunch.

It's also important to consider how these risk reduction benefits may vary depending on the specifics of the liability profile. In particular, what if the liability profile has a longer duration than the long duration fixed income benchmark that the plan is using? Here we can do the same analysis but we change the mature liability profile we have been using throughout this paper which has an 11 year duration to a more average liability profile with a 14 year duration. Figure 9 summarizes the results.

Figure 9: Benefits of Level 2 LDI – average liability profile

	LHA Component			Improvement in Funding Ratio (Level 2 vs. Long Gov't / Credit)	
Equity Allocation	Long Gov't / Credit	Level 2	Risk Reduction	4/1/2000 - 9/30/2002	7/1/2007 - 3/31/2009
60	12.1%	9.1%	-25%	9%	12%
40	8.8%	6.2%	-29%	8%	7%
20	5.9%	3.7%	-37%	8%	2%

Source: Bloomberg, Bank of America Merrill Lynch, and Barclays

Comparing Figure 8 to Figure 9 we can make the following key observations:

- Risk reduction is greater for the young profile across all key metrics. This is because there is, compared to an average liability profile, an even larger amount of interest rate risk in the liability that cannot be hedged using just a long government / credit market benchmark. The interest rate derivatives used in the Level 2 solution are not constrained by any market benchmark or capital requirements and are therefore able to hedge away unwanted interest rate risk.
- The absolute risk levels of the Level 2 LDI solutions are almost identical for both the average and young liability profiles. This is because Level 2 LDI solutions neutralize the interest rate risk and credit spread risk in the liability. With the liability risk neutralized the funding ratio is exposed to only equity market risk so the specifics of the liability profile do not impact the amount of remaining funding ratio risk.
- As equity exposure is reduced the benefits of using a Level 2 LDI approach and an explicit liability benchmark increase significantly for the young liability profile. This is because the long government / credit benchmark is a reasonable hedge for the mature liability profile but is a poor hedge for the longer duration average profile. Therefore the benefits of abandoning the long government / credit approach and using a custom liability benchmark within the Level 2 LDI solution are quite large. In addition, the benefits of using a liability benchmark increase as equity risk is reduced and no longer dominates the overall funding ratio risk budget.

While we do not model it here, there would be a similar increase in risk reduction benefits for plans that are underfunded. This is because as the dollars of assets fall relative to liabilities the dollar amount of interest rate risk increases. Therefore, the benefits of

using interest rate derivatives within a Level 2 LDI solution increase as they can attain the desired level of interest rate hedging in a capital efficient manner.

Beyond the risk reduction benefits we have discussed there are additional benefits that come along with a Level 2 LDI solution. These are the risk monitoring and performance reporting benefits that comes along with moving away from market benchmarks to using a custom liability benchmark. This is important because by adopting an LDI framework plan sponsors are switching their investment objective from long-term asset-only return to the objective of either matching performance of the liabilities or outperforming it by some margin. With this shift in objective, it is crucial to have a liability benchmark in place for the overall plan as well as for the LHA component (although the benchmark for the LHA component needs to be scaled to reflect the target interest rate hedge ratio, credit spread hedge ratio, and amount of capital allocated to it). Doing so will allow the plan's investment committee to assess how much risk they are taking relative to liabilities, whether or not they have achieved their plan level liability-relative objective, and whether or not their hedging program has been successful. This is all part of good investment governance for LDI adopters as an essential element to good governance is simply having the relevant information for an investment committee to determine what risks they are taking and if the decision that they have made is working. While we will cover the topic of effective LDI performance measurement in greater depth in a future paper, we want to emphasize here that utilizing an explicit liability benchmark for overall plan performance and performance of the LHA component does help facilitate good investment governance for LDI adopters.

Continuing in the spirit of good governance, the benefits we have discussed that come with a Level 2 LDI solution must be balanced against the additional costs and, if derivatives are needed, the derivatives-related risks that come with it. Specifically with respect to derivatives-related risks, we discussed one of these (mark-to-market derivatives risk) in the previous section. Two other derivatives-related risk factors often cited are attributable to counterparty risk and knowledge risk. While these are certainly valid concerns, it is worth noting that exchange traded derivatives (i.e. Treasury futures) can be utilized to implement derivatives-based exposure in an effective way and also reduce counterparty risk and some of the educational burden.

With respect to costs, moving to Level 2 may require an increase in the plan's governance budget in order to provide the necessary education, liability and/or derivatives-based reporting, hiring of an external LDI manager, and procedures and documentation around the management of derivatives, if derivatives are needed. In our experience we find that these costs vary considerably depending on the plan sponsor's situation. For large plans with large dedicated investment staffs, the incremental cost associated with a Level 2 LDI solution are quite small as they often have less educational needs and have derivatives-based policies, procedures, and documentation already in place. However, for smaller plans with no full-time dedicated staff these incremental governance costs can be substantial.

So, it could be argued that, depending on the plan sponsors situation, the 15% risk reduction benefits for the mature liability profile do not outweigh the additional governance burden of a Level 2 LDI solution. However, we suggest putting this into perspective. Consider a plan that is looking to reduce volatility by diversifying their sources of return away from equities and into hedge funds. This plan would need to allocate 20%-25% of the equities to hedge funds to achieve the same 15% reduction in volatility. We would suggest that implementing a large hedge fund program carries with it an even larger governance burden and risk than implementing a Level 2 LDI solution. Further, these hedge funds would need to outperform equities by a very wide margin to deliver the same amount of funding ratio protection during periods of economic stress. For example, consider the credit crunch period where the Level 2 LDI solution buoyed funding ratios by 10% for a plan with 60% exposure to equities. To achieve this same amount of funding ratio improvement, the hedge fund program would need to outperform equities by 50% over that period.

Overall, it is our view that Level 2 LDI solutions offer enough incremental benefits to justify the additional costs that come with it. This is especially true for plans that have somewhat longer liability profiles, are underfunded, and/or have the capacity to implement the appropriately sized governance budget to support the Level 2 LDI solution. With that being said, we acknowledge that there are plan sponsor situations that do not allow for an appropriately sized governance budget and in these situations, Level 2 LDI may not be appropriate.

3. **What are the benefits of implementing via a synthetic equity approach?**

For clients that choose to rely on derivatives to implement a Level 2 LDI solution, we have seen two different ways of implementing the target hedge ratios and equity exposure. Traditionally, Level 2 LDI adopters have implemented their desired interest rate and credit spread hedge ratios by utilizing interest rate and credit derivatives within the LHA component to extend duration and attain the desired levels of hedging. This way most of the capital can be freed up for physical investment in equities and other return-seeking assets allowing the plans to maintain their long-term expected return. We refer to this method of implementing Level 2 LDI as "synthetic liabilities".

Recently, we have seen plan sponsors utilize a different approach which we refer to as "synthetic equities". Using this approach, most of the capital is allocated to physical long duration bonds in order to achieve the target hedge ratios without having to use interest rate and/or credit derivatives. The target equity exposure is then achieved by utilizing a portfolio of equity derivatives (i.e. equity futures) which are only partially backed by cash collateral. The rationale for this approach is typically (1) the belief that physical bonds are a better liability hedge than interest rate and credit derivatives and (2) equity derivatives can cheaply and effectively deliver the returns of a physical equity investment.

Let's look at an example to help clarify the differences between the synthetic liability and synthetic equity approaches. Let's assume a plan with $100 in assets and liabilities. The plan would like to target a 60% equity exposure, 80% interest rate hedge, and a 60% credit spread hedge. The synthetic liability approach would allocate $60 to physical equities and $40 to an LHA component. The $40 would be invested in a combination of physical corporate bonds, Treasury bonds, and cash. The Treasuries and cash would be there to back up a significant synthetic exposure to interest rate and credit derivatives needed to achieve the target interest rate and credit spread hedge ratios. The synthetic equity approach would allocate $80 to physical bonds ($60 to credit, $20 to Treasuries) to achieve the target interest rate and credit spread hedge ratios and $20 to cash. The $20 in cash plus the Treasuries would there to back up a $60 synthetic exposure to equities.

When evaluating which approach is most appropriate for plan sponsors the two key considerations tend to be (1) how much more

effective of a hedge can I get by using physical bonds vs. using interest rate and/or credit derivatives, and (2) what impact will this have on expected return and yield on the overall portfolio?

In order to evaluate the relative effectiveness of the liability hedge we will focus our analysis on the effectiveness of the credit spread hedge as opposed to the interest rate hedge. This is because it is generally accepted that the interest rate hedge can be effectively, if not perfectly, implemented with either physical Treasuries or interest rate derivatives (i.e. Treasury futures or interest rate swaps) while it is less clear how effective credit derivatives (i.e. CDX) are at hedging the credit spread risk in pension liability discount rates. In order to analyze the effectiveness of using credit derivatives we compare the historical hedge effectiveness of a corporate bond-based hedge vs. a synthetic corporate bond portfolio implemented via Treasuries plus CDX investment grade exposure. Figure 10 summarizes the results.

Figure 10: Comparison of historical hedge effectiveness of physical corporate bonds and synthetic corporate bonds

			Corporate Bond (A-AAA) Hedge			Treasury + CDX		
Time Period	Dates	Liability Return	Return	Correlation with Liability Return	Tracking Error	Return	Correlation with Liability Return	Tracking Error
CDX - 1	3/1/2004-6/30/2007	12%	13%	99%	0.9%	18%	98%	1.5%
CDX - 2	7/1/2007-3/31/2009	3%	-5%	98%	3.2%	5%	87%	8.6%
CDX - 3	4/1/2009-12/31/2010	33%	33%	98%	1.5%	21%	82%	4.7%
CDX - Aggregate	3/1/2004-12/31/2010	55%	41%	98%	1.9%	51%	89%	5.1%

Source: Bloomberg, Bank of America Merrill Lynch, and Barclays

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. Treasury-based 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 Treasury Liability Index and the Bank of America Merrill Lynch Retired US Pension Plan Treasury 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 Treasury + 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.

For the aggregate time period (we start our time series in March 2004 as CDX did not exist prior to that date) utilizing CDX offers a significantly higher tracking error (5.1% vs. 1.9%) relative to the physical corporate bond-based hedge. This is a bit surprising given that CDX exposure is meant to be representative of corporate bond credit.

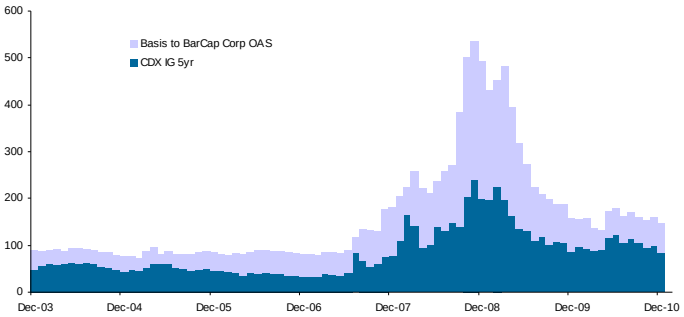
However, there are a few reasons why using CDX has its limitations for effectively hedging the credit spread risk in pension discount rates. First, there is a significant amount of basis risk between CDX and its underlying corporate bonds. During the 2007-2009 credit crisis, this basis risk took the form of a very large negative basis where corporate bond yields were almost 400 basis points higher when compared to the equivalent Credit Default Swaps (CDS) on the same names. This large negative basis typically occurs during periods of economic stress as the unfunded nature of CDX becomes a very attractive way to maintain credit exposure as liquidity dries up in the capital markets. This is why you see the CDX-based hedge outperform during the 2007-2009 credit crisis period. Second, CDX instruments are only liquid up to five-year or ten-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 exposed significantly to changes in the shape and slope of the credit spread curve. Last, the CDX Investment-Grade Index has a large 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.

Clearly, a synthetic credit spread hedge is not as effective as a hedge via corporate bonds. However, it is worth putting this insight into perspective. First, the benefits of a more effective hedge via a synthetic equity approach is really only relevant for plan sponsors who desire a credit spread hedge ratio greater than what they could achieve with the capital allocated to the LHA component of assets. For example, take a situation where 60% of assets need to be allocated to corporate bonds to achieve the target credit spread hedge ratio but a 60% exposure to equities is needed to achieve the desired level of expected return. As aforementioned, when viewing risk from a total portfolio perspective we do not typically advocate such a high credit spread hedge ratio combined with a large equity allocation. However, this situation can occur for a variety of reasons – whether it is a longer duration liability profile, an underfunded plan, and/or simply a different philosophical approach to managing credit spread risk. So for plans that are looking to simultaneously achieve a high credit spread hedge along with a large equity portfolio, it may be appropriate to do so (at least partially) by synthetically replicating the equity exposure.

Second, it is also important to consider these benefits from a total portfolio context. Specifically, the larger the allocation to the RSA component, the less meaningful the benefits will be of the more effective corporate bond-based hedge. This is because a large allocation to assets such as equities introduces so much volatility to the portfolio it dominates the overall risk budget and drowns out the benefits of a more effective hedge. Couple this with the fact that historically CDX investment grade has been less correlated with equities than corporate bonds and the benefits of using a corporate-bond hedge have been virtually eliminated. For example, the historical volatility of a portfolio with a 60% equity exposure and a 100% credit spread and interest rate hedge ratio have almost identical risk whether the hedge is implemented via corporate bonds (10.6%) or Treasuries plus synthetic credit (11.2%). And, for plan sponsors with small allocation to an RSA component there is typically enough capital available to achieve the target credit spread hedge without having to free up additional capital by selling equities. Thus in most cases, from a risk mitigation standpoint, there is little difference between the two approaches. However, in the case where there is a low equity exposure (i.e. 20%) and there is still not enough capital available to achieve the target credit spread hedge it has been more effective to utilize the synthetic equity approach.

Beyond risk mitigation it is also important to consider the potential impact of each approach on returns. The potential benefit of the synthetic liability approach is that alpha may be earned on the physical investment in equities. The potential benefit of the synthetic equity approach is that a higher yield may be earned on the physical bonds versus the CDX investment grade. While the alpha expectations vary significantly by asset class and by plan the difference in yield between investment grade corporate bonds and CDX investment grade can be analyzed. Figure 11 shows the historical basis between the Barclays US Corporate Investment Grade Index and CDX Investment Grade Index from October 31, 2003 thru December 31, 2010.

Figure 11: Historical basis of CDX Investment Grade vs. Corporate Bonds



Source: Barclays

While the basis has been volatile it has always resulted in corporate bonds yielding more than CDX. On average, the basis has been 76 basis points and as of December 31, 2010 it stood at 62 basis points. Assuming all else equal, you would need to assume an equity alpha target greater than the combination of this basis and the corporate bond alpha target in order to justify leaving the capital in physical equities. Assuming an alpha target on corporate bonds of 75 basis points and a CDX basis of 75 basis points you would need an equity alpha target of at least 150 basis points. While alpha targets on equities can be quite large depending on the specific strategy, there are certain strategies (i.e. US large cap equities) where this target may be a bit of a stretch. Lastly, the relative costs of financing the synthetic equities and liabilities should also be factored in when evaluating the merits of both approaches.

In summary, we have concluded the following for plans that are seeking to achieve a credit spread hedge ratio beyond what is possible with the capital allocated to the LHA component. From a risk mitigation standpoint, the benefits of using a physical credit spread hedge increase as the equity exposure decreases. From a yield enhancement perspective, the benefits of synthetic equities can be significant assuming an average CDX basis, a moderate level of alpha expectation that is forgone when selling the physical equity portfolio, and a similar cost of financing for both synthetic liabilities and synthetic equities. Therefore, we find that in these high target credit spread hedge ratio situations a synthetic equity approach can be the most efficient way to implement a Level 2 LDI solution.

Conclusions

We find that successful Level 2 LDI implementation is dependent on effectively determining (1) the appropriate levels of interest rate and credit spread hedging, (2) if the efficiencies gained via Level 2 LDI exceed the costs that come with it, and (3) if synthetic equities or synthetic liabilities should used to implement the desired set of derivatives exposures, if needed.

Consistent with our Level 1 LDI research, we believe that the answers to these questions lie in maintaining a total portfolio perspective. We also find that the answers to these questions change as the plan sponsor de-risks the plan by moving assets from a RSA component to a LHA component. More specifically we make the following three key observations.

First, we find that, strategically, the vast majority of interest rate risk should be hedged. We find this to be true even when there is a very large exposure to an RSA component. Further, we find that the strategic credit spread hedge ratio is dependent on the size and composition of the RSA component. The bigger and more equity-like the RSA component, the lower the strategic credit spread hedge ratio should be.

Second, we find that the risk reduction benefits and the importance of using a liability benchmark are significant, likely outweigh the costs, but are dependent on several factors – liability profile, funded status, and size of the RSA component. Importantly, the incremental improvement to funding ratios are especially large when they are needed the most - during periods of economic stress.

Third, using synthetic equities to free up capital to hedge with a physical corporate bond portfolio can increase the effectiveness of the credit spread hedge and may add to portfolio yield. Importantly, these benefits are only relevant for plan sponsors who desire a target credit spread hedge ratio beyond what can be achieved without freeing up more capital by synthesizing at least part of the RSA component.

Based on the relevant risk-return assumptions, our views on the three key Level 2 LDI implementation considerations are summarized in Figure 12 below.

Figure 12: Summary of key Level 2 LDI implementation considerations

Equity Exposure	60%	40%	20%
Target Hedge Ratios			
Interest Rate	80%	90%	100%
Credit Spread	10%	30%	50%*
Benefits of Level 2 LDI (Relative to Long Government / Credit)			
Volatility Reduction (Mature Plan)	-15%	-15%	-14%
Volatility Reduction (Average Plan)	-25%	-29%	-37%
Funding Ratio Improvement During Period of Stress (2000-2002 Recession)	8%	6%	5%
Importance of a Liability Benchmark for the LHA component	High	Higher	Highest
Benefits of Synthetic Equities			
Risk Mitigation	Smaller	Small	Moderate
Yield Enhancement**	Significant	Significant	Significant

*Particularly for frozen pension plans, other factors such as how close the plan is to ultimate funding target needs to be taken into account and may drive the appropriate strategic credit spread hedge ratio down considerably

**Here we assume there is only a moderate amount of alpha forgone when selling physical equities and a similar cost of funding for both synthetic equities and synthetic liabilities

Appendix

Long-Term assumptions

	Return
Liabilities	5.30%
Treasury Hedge	4.35%
Credit Hedge*	5.10%
Equities	8.50%

* Spread over Treasuries based on historical spreads adjusted for expected defaults, transaction costs, and fees

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