Managing Volatility in Liability Driven Investing
A Three-Factor Framework

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Overview

Liability Driven Investing (LDI) has become a mainstream approach to managing pension financial risk for corporate pension plans. Plan sponsors have increased their asset allocations to pension hedging strategies and are looking to increase them in the future to mitigate additional liability risk. The growing importance of LDI underscores the need for a framework to create, measure, and manage the effectiveness of these hedging strategies.

In this paper, we outline a three-factor framework for hedging pension liabilities. We quantify the volatility of pension liabilities according to these three factors, addressing them in order from most impactful to least. We also suggest hedge ratios to quantify the link between liability and funded status volatility.

Hedging Framework

We believe a three-factor framework can describe and monitor the effectiveness of a hedge against unexpected changes in the pension plan liability. These three factors are:

- The level of interest rates;
- The spread of corporate bonds above U.S. Treasury yields (credit spreads); and
- The slope of the U.S. Treasury yield curve.

For each of these three factors, we suggest a hedge ratio to measure how effectively the LDI strategy protects the pension funded status from each risk. For example, a hedge ratio of 100% indicates the funded status will remain unchanged despite changes in the liability. Essentially, the strategy fully hedges funded status against the risk of an increased liability.

Interest Rates

We define interest rates as the yield curve (the term structure of interest rates between two years and 30 years). Within our three-factor framework, we differentiate between changes in the level of the yield curve and fluctuations in its slope. We quantify variations in the level of the yield curve by looking at changes in the yield of the 10-year Treasury note (10yr). These changes are the greatest source of volatility in pension liabilities.

In Figure 1, we show the monthly movements in a representative set of pension liabilities attributable to interest rate changes during the period December 31, 2005 through September 30, 2017. Positive numbers represent an increase in pension liabilities due to a decrease in the yield of the 10yr.

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Figure 1

Liability Change from Rates:Tsy10
(M/M %)
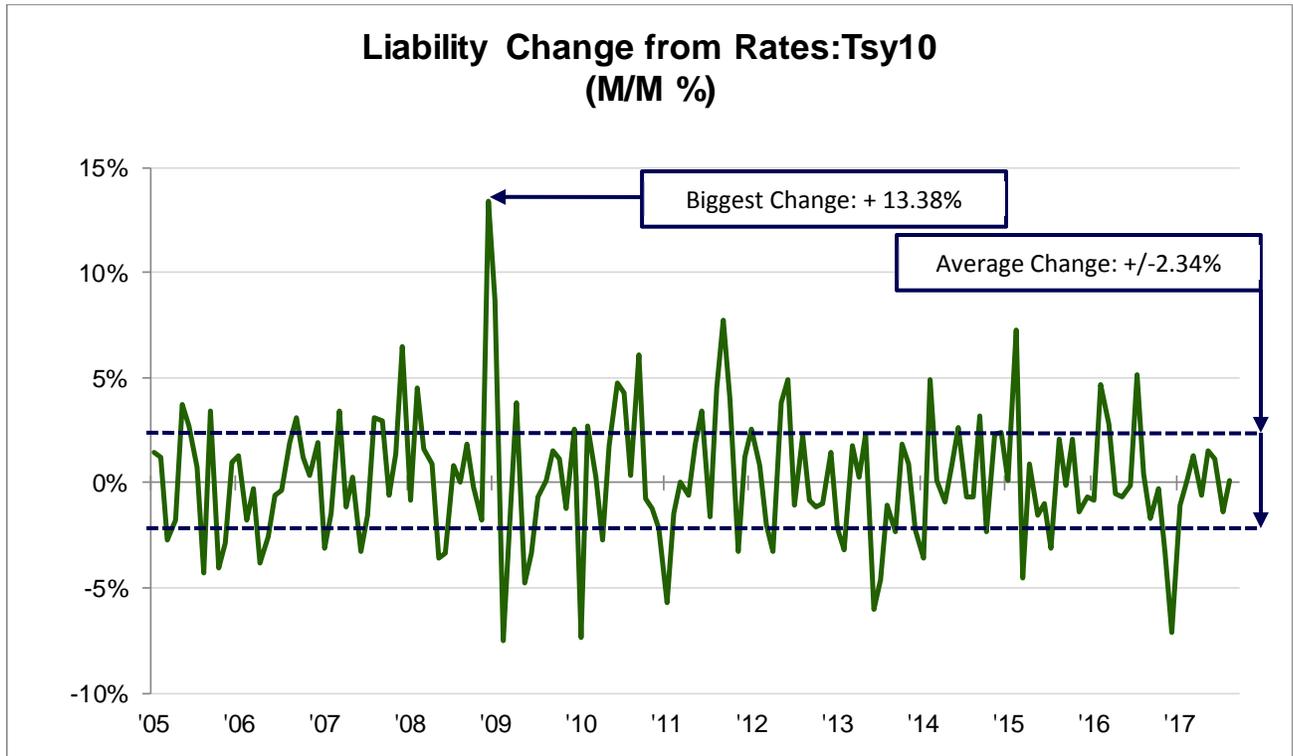
During this period, the largest change in liabilities occurred during November 2008, when concerns about contagion of the U.S. financial crisis into the global economic system led to a flight to quality. On October 31, 2008, the yield on the 10-year Treasury was 4.01%. By the end of November 2008, the 10-year was 2.93%, lower by 118 basis points (bps). For the representative pension benefit cash flows, this drop in rates increased liabilities by 13.38%. The average monthly pension liability change during this period was 2.34%.

The interest rate hedge ratio is the relationship between liability and funded status volatility. This ratio is the dollar change in the assets divided by the dollar change in liabilities created by a fluctuation in interest rates. It is the mathematical product of three levers the pension plan sponsor can control: the funded status of the plan; the asset allocation to bonds; and the ratio of the duration of the bond portfolio relative to the liabilities.

Funded Status	X	Bond Allocation	X	Bond Duration / Liability Duration

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Example: a plan is 85% funded with 40% of assets in bonds with a duration of 14 years. If the plan hedged liabilities with a duration of 12 years, then it would have an interest rate hedge ratio of 40%.

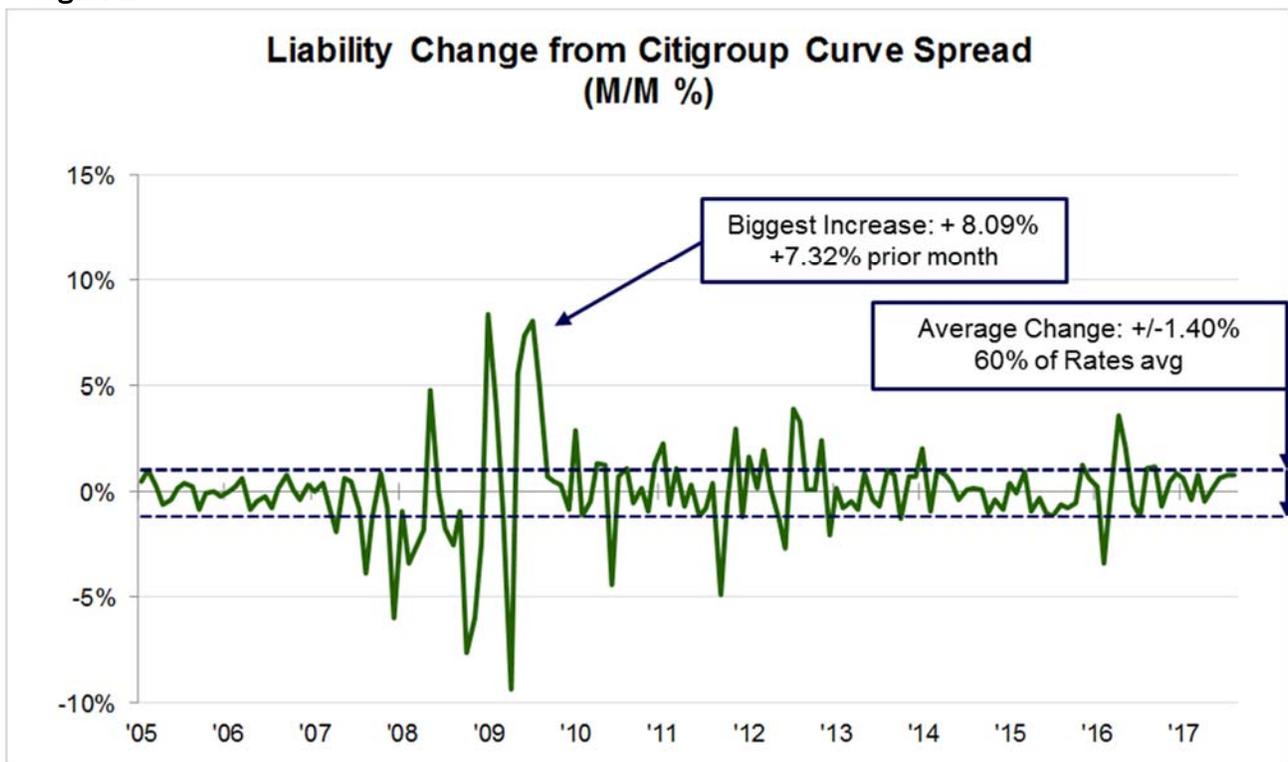| 85% Funded | X | 40% Bond Allocation | X | Bond Duration of 14 years / Liability Duration of 12 years | = | 40% Interest Rate Hedge Ratio |

Credit Spreads

In our analysis, credit spreads are the difference between the yield on corporate bonds and comparable U.S. Treasury securities. Higher quality bonds have tighter (smaller) credit spreads. When economic conditions worsen/(improve), spreads widen/(tighten). Higher quality bonds experience less widening/tightening than lower quality bonds.

Because pension liabilities are calculated using the yields of corporate bonds, changes in credit spreads cause pension liability volatility. Because rates and spreads move independently and are hedged differently, we consider credit spread volatility separate from interest rate changes.

In Figure 2, we show the monthly liability changes attributable to movements in credit spreads. Positive percentages represent an increase in pension liabilities resulting from a decrease/tightening in credit spreads.

Figure 2

Liability Change from Citigroup Curve Spread (M/M %)

Biggest Increase: + 8.09%
+7.32% prior month

Average Change: +/-1.40%
60% of Rates avg

During this period, the largest changes in liabilities occurred during May-June 2009. As markets began to normalize after the onset of the 2008 credit crisis, spreads tightened by 72 bps in May 2009 and another 65 bps in June 2009. Due to this spread compression, liabilities for pension plans increased 8.09% in May 2009 and 7.32% in June 2009. The average monthly change in liabilities from credit spreads during the almost 12-year period was 1.40%.

Credit spread volatility represents 60% of the changes due to rates. Although they are less important than changes in interest rates, credit spreads are an important source of liability volatility which must be managed to achieve an effective hedge.

The effect of spread volatility on the funded status of plan liabilities is measured by the credit spread hedge ratio. Similar to the interest rate hedge ratio, it is modified by replacing the ratio of asset and liability duration with the ratio of asset and liability duration times spread (DTS).

Funded Status	X	Bond Allocation	X	Bond DTS / Liability DTS

We use the earlier example: a plan is 85% funded with 40% of assets in bonds with a duration of 14 years and is hedging liabilities with a duration of 12 years. Additionally, we consider the spreads of the bond portfolio and the liabilities. In this example, these are 90 bps and 97 bps, respectively. This scenario results in a hedge ratio of 37%.

| 85% Funded	X	40% Bond Allocation	X	Bond DTS of 14 years * 90 bps ÷ Liability DTS of 12 years * 97 bps	=	37% Credit Spread Hedge Ratio

Slope of the Yield Curve

The rates hedge ratio is the most important measure of pension risk. However, it is based on duration and only addresses parallel changes in the yield curve. The third factor in our framework focuses on non-parallel changes: movements in the slope of the yield curve.

We follow a similar format in Figure 3. The scale of the vertical axis illustrates the relative impact of changes in the slope of the yield curve. This graph shows these changes are small relative to the previous two scenarios we examined. Positive percentages represent an increase in liabilities from yield curve flattening.

Figure 3

Liability Change from Rates Slope/Shape (M/M %)
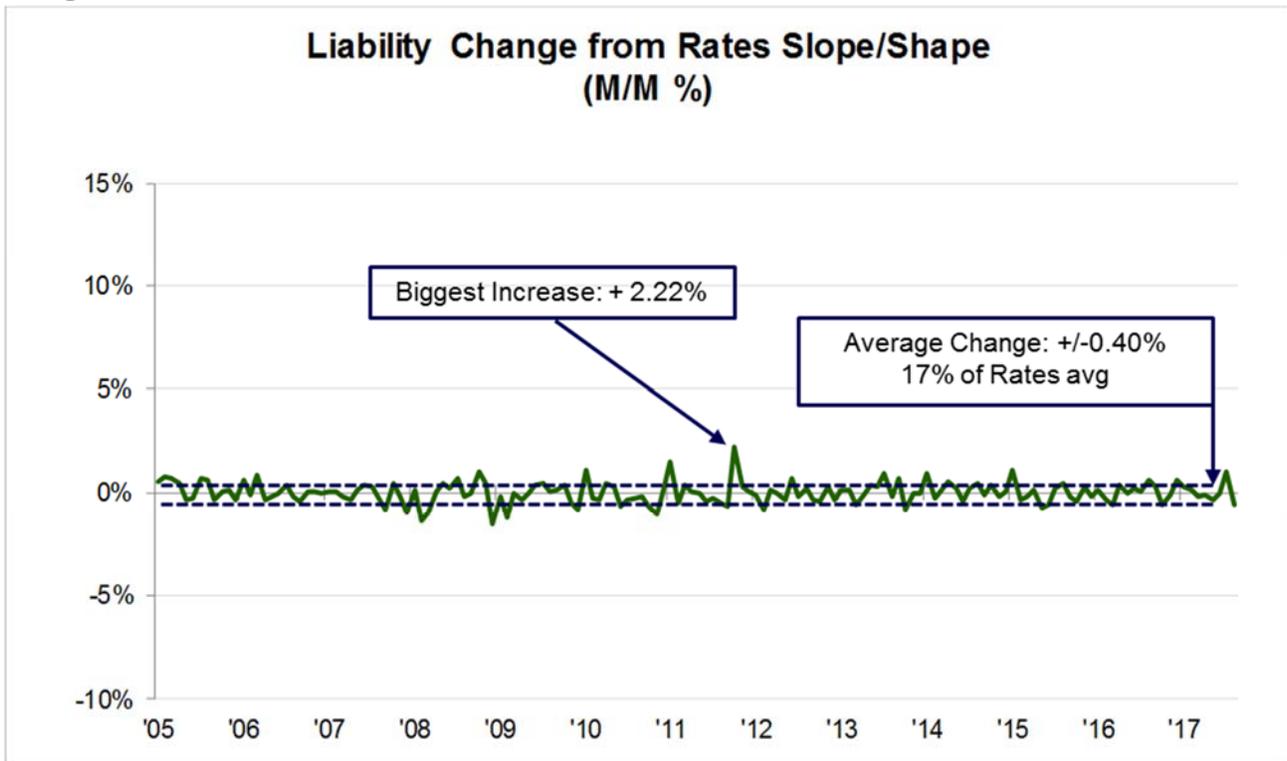
During the time period in this scenario, the largest liability increase occurred in September 2011. Media reports in the weeks prior to an official announcement indicated the Fed was going to implement a program to more aggressively reduce long-term interest rates. The Fed announced its "Operation Twist" plan in September 2011 to make open market purchases of longer-dated maturities to further reduce nominal interest rates to stimulate additional economic growth. Markets anticipated these purchases and the yield curve flattened.

The slope of the yield curve (difference in yields between the 2-year and the 30-year U.S. Treasury) was 340 bps at the end of August 2011. In the following month, the curve flattened 75 bps to 265 bps. The impact of this flattening was an increase in liabilities of 2.22%. During this period, the average of the monthly changes in liabilities due to the flatter yield curve was 0.40%

Yield curve changes equate to 17% of the volatility caused by movements in rates. These results indicate the changes in the slope of the yield curve are the least impactful of the three factors. The effort to measure and hedge against yield curve slope risks should also be kept relatively modest.

Conclusion

In this paper, we have outlined a three-factor framework to hedge pension liabilities. We have quantified the impact of each factor using representative pension benefit cash flows and historical market conditions. We have also suggested hedge ratios to quantify the impact of liability volatility on changes to funded status.

Changes in the level of interest rates cause the majority of pension funded status volatility. Changes in spreads are the next most important source of volatility, equal to 60% of the level caused by rate fluctuations. Yield curve changes are the least impactful and only equate to 17% of the volatility caused by movements in rates.

Finally, we note this analysis was performed using a representative set of pension benefit cash flows. Pension plans with atypical benefit cash flows will have different sensitivities to rates, spreads, and yield curve slope changes.

BHMS Capabilities

Barrow, Hanley, Mewhinney & Strauss has successfully established a 28-year track record managing long duration portfolios to effectively hedge pension liabilities. We currently manage $5.3 billion for LDI clients. We have seen interest in our LDI capabilities from consultants and plan sponsors who want to diversify from strategies employed by other, typically larger, LDI managers.

Due to the significant size of our equity assets under management, we have an unparalleled ability to engage directly with senior management of U.S. corporations that issue longer duration securities. The BHMS fixed income team leverages the research strength of the entire firm in the fundamental analysis of all issuers in the Long Credit Index. Our ability to perform bottom-up, fundamental credit research provides our clients a distinct advantage in our analysis and security selection. Also, the "boutique" size of our fixed income assets provides an advantage in our credit selection and portfolio structure.

We have investment actuarial expertise within our team which complements both plan monitoring for established LDI plans and implementation for new LDI plans. We work collaboratively with plan sponsors, their investment consultants, and plan actuaries to develop, implement, and monitor LDI strategies for traditional and cash balance plans.

For more information on any of BHMS' investment strategies, please contact Bill Braxton at 214.665.1900 or email market@barrowhanley.com.

Appendix 1 – Methodology for Attribution of Liability Volatility

To quantify the monthly change in liabilities, we began with a set of representative projected pension benefit cash flows (benefits). These were created using the Russell pension Standard Cash Flow Generator (SCG) and calibrated to match characteristics of the average corporate pension plan. These average statistics were drawn from Forms 5500 filed for the 2015 plan year for single employer plans. The liabilities of these plans were 50% retiree, 35% active employee, and 15% vested-terminated former employees. They have a duration of 11.3 years.

We used the Citigroup pension discount curve to calculate the liabilities from these benefits for each month beginning December 31, 2005 through September 30, 2017. We refer to this liability as the Citigroup liability.

To determine the volatility attributable to rates, we valued the liabilities using a discount curve constructed by adding the monthly change in the yield on the 10-year U.S. Treasury note to the prior month Citigroup yield curve. We refer to this liability as the rates liability. We subtract the prior month Citigroup liability from the rates liability to determine the change due to the movement in rates.

To determine the change attributable to slope of the yield curve, we valued the benefits using our own constructed discount curve. We added the change in the yield at each annual point on the yield curve to each annual rate in the prior month Citigroup yield curve. We refer to this liability as the curve liability. We subtract the curve liability from the rates liability to determine the difference in the liability due to the variability in the slope of the yield curve.

To determine the change attributable to credit spreads, we subtract the current month Citigroup liability from the curve liability.

Each of these changes is divided by the prior month Citigroup liability to express as a percentage change.

We obtained the data used in this paper from Bloomberg, Citigroup, and Judy Diamond and the Society of Actuaries. BHMS performed the calculations.