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Liability-Driven Perspectives

The Hidden Cost of Mismatching Duration

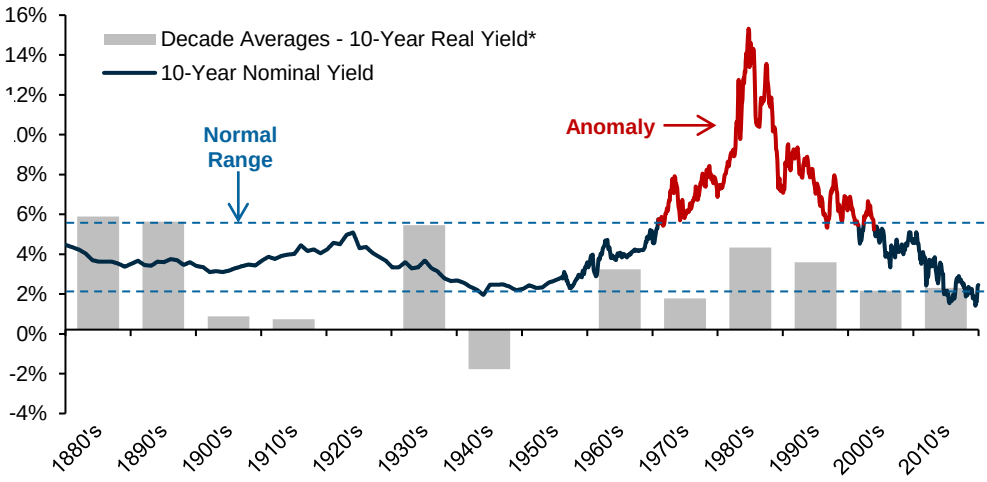
Many pension plan sponsors may be hoping that sharply rising interest rates will help return them to full funding. Among U.S. corporate defined benefit pension plans, we observe interest rate hedge ratios[1] from as low as 5% to as high as 105%. The typical hedge ratio is probably somewhere between 20-40%. However, mismatching duration is not a costless bet. Most asset allocation approaches do not include an estimate of the term risk premium and, in not doing so, exclude the expected cost of unhedged interest rate risk. In this paper, we explore:

- *What the term premium is and how to estimate it;*
- *Why we believe duration mismatching is expected to cost the typical U.S. plan around 1% in funded status annually;*
- *Strategic asset allocation considerations to reduce this 'hidden' cost.*

The Anomaly, Not the Norm

Many plan sponsors undoubtedly remember much higher levels of prevailing interest rates from the 1970s, 1980s and even 1990s. In fact, many may consider those high rates to be "normal." If you look at a longer history of U.S. interest rates, however, that period of high rates appears to be an anomaly, not the norm.

LONG-TERM U.S. TREASURY RATES
1875 – December 2016



** Real Yield = 10-year nominal U.S. Treasury yield less the trailing 5-year moving average of the year-over-year change in CPI.*
Sources: 1875-1961, Robert Shiller, Yale; 1962-Present, Bloomberg.

[1] *Interest rate hedge ratio is defined as dollar duration of assets / dollar duration of liabilities.*

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While some investors' expectations for future interest rates may be anchored to that anomalous period, we believe those higher rate levels are unlikely to be repeated. As Robert Tipp, Chief Investment Strategist at PGIM Fixed Income, explains in a series of white papers, a much greater focus on price stability by central banks, aging global demographics, and lower productivity and growth lead us to believe this lower rate paradigm will be prolonged. See below for a list of Mr. Tipp's papers, located at PGIMFixedIncome.com.[2]

Rather than waiting, or hoping, for interest rates to rise, we believe plan sponsors should focus on the strategic asset allocation implications of under-hedging the interest rate risk in their liabilities. We find a positive risk premium in the term structure of interest rates. This means plan sponsors pay a cost in expected reduced funded status each year their liabilities are under-hedged.

Finding the Term Risk Premium

Term risk premium is the extra return investors expect to earn for accepting the incremental duration risk of long-maturity bonds relative to shorter-maturity bonds. It is created by the steepness in the yield curve. But there are other factors that influence the slope of the yield curve (such as expectations for changes in the Federal funds rate and convexity effects), which make it difficult to isolate the risk premium. Below, we examine three different methods for estimating a range for the term risk premium and then consider the implications for pension plans.

I. A Historical Estimate of the Term Premium

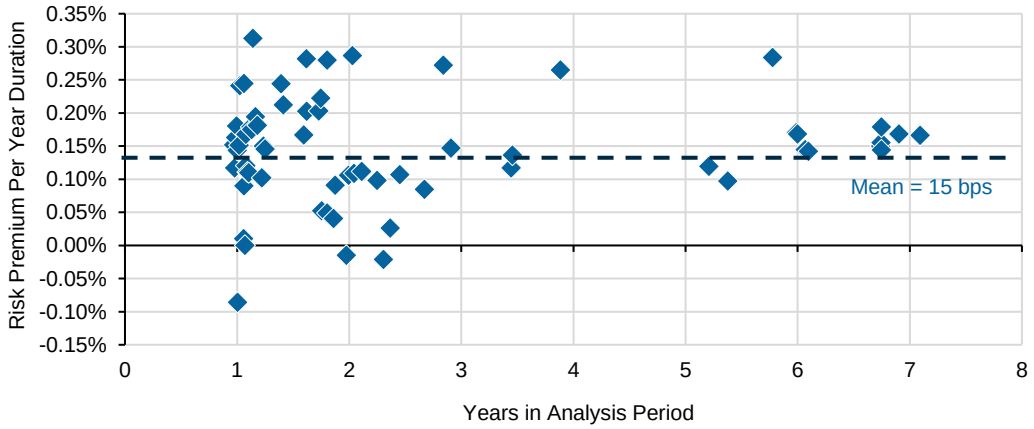
One way to measure the term premium is to examine the returns of long-maturity bonds relative to shorter-maturity bonds. To control for changes in both the level and steepness of the yield curve, we only consider periods[3] in which the yield on both the Long Treasury and Intermediate Treasury indices started and ended the period at the same yield level. By focusing on these periods we reduce any bias from the steady trend downwards in interest rates over the past 20 years.

In each period, we measure the excess return of the Long Treasury Index over the Intermediate Treasury Index, annualize this excess return, and divide by the difference in duration of the Long and Intermediate indices in each period. This gives us a measure of the annual excess return of Long Treasuries over Intermediate Treasuries per year of duration.

The chart below illustrates this estimate of the long-end term risk premium per year of duration gap for each period, graphed against the length of each period in the analysis. As you can see, the mean premium is 15 bps per unit of duration. Not surprisingly, over longer periods, the estimated risk premium has tended to be close to the mean.

SCATTER OF REALIZED TERM PREMIUM BY NUMBER OF YEARS IN ANALYSIS PERIOD

Excess return of Long Treasury Index over Intermediate Treasury Index per unit of duration



Source: PGIM Fixed Income as of March 31, 2017

[2] *"The Bond Bulls Twain Moment," (April 2017); "Central Banks of the World: Yield to the Markets!" (August 2016); "The Totally Mad World of Low Rates," (December 2015).*
[3] *Consider only periods of longer than 12 months, Bloomberg Barclays Long Treasury and Intermediate Treasury Indices daily data from May 1997 to March 2017.*

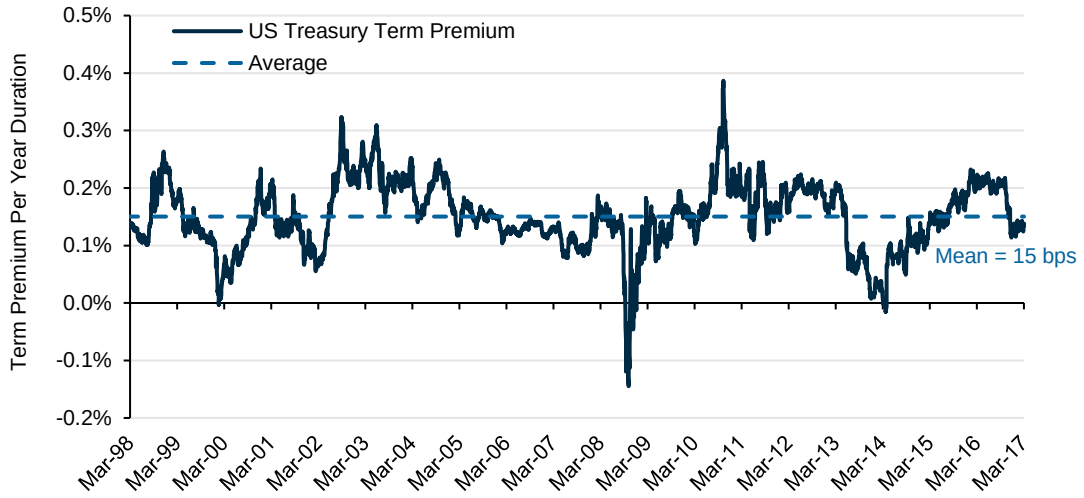
It is worth noting that the same analysis at the short end of the yield curve may produce substantially higher estimates for the term premium. However, our analysis is focused on long-end risk premium since that is where a pension plan's duration gap is most meaningful.

II. A Theoretical Estimate of the Expected Term Risk Premium

The empirical study above only explains what happened in the past and plan sponsors would be right to ask what we *expect* for the future. But extracting the market's current expectation for the term premium is not a trivial task as there are several factors that drive the shape and steepness of the yield curve.

An important modeling process run daily within PGIM Fixed Income is our structural yield curve fit of over 40 different global government bond and swap markets. This is a two-factor stochastic short rate model of the term structure that attempts to fit a smooth curve to the typically noisy set of bond prices observed in the market. One of the outputs from this model is an estimate of the term premium in each market. The chart below illustrates the model's estimate of how the term premium from the U.S. Treasury market has changed through time, averaging 15 bps per year of duration over the period.

US TREASURY TERM PREMIUM



Source: PGIM Fixed Income as of March 31, 2017

Interestingly, the 15 bps average U.S. Treasury term premium from our yield curve fit is essentially the same as the empirical result. When we apply the same modeling process to other global sovereign bond markets, we also estimate positive term premia, on average, over time:

	U.S.	Germany	UK	Japan	Canada
Average Term Premium[4]	0.15%	0.09%	0.12%	0.15%	0.07%

Source: PGIM Fixed Income as of March 31, 2017

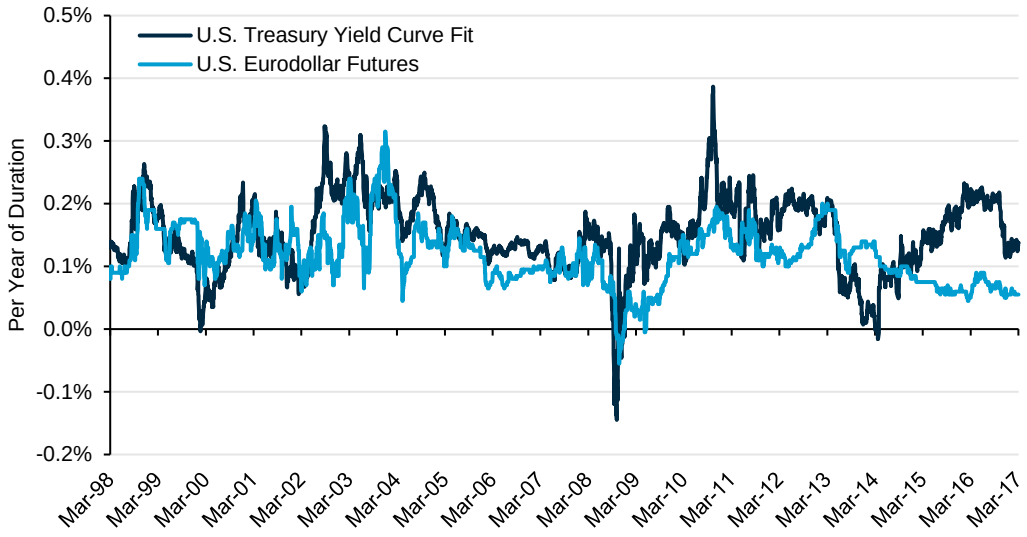
[4] *Term premium estimate periods as follows: U.S. Treasuries: 1998-2017, German Bunds: 2011-2017, UK Gilts 2011-2017, Japanese Gov Bonds: 2003-2017, Canadian Gov Bonds: 2011-2017.*

III. A Real-World Check

Estimating the expected term risk premium from the parameters of a stochastic interest rate model is a relatively theoretical exercise. A more direct estimate of the market's expectation of the term risk premium can be found in Eurodollar future markets. This provides a 'real-world' check to compare to our historical and theoretical estimates.

Since there is no convexity effect in Eurodollar futures, and if we can make a leap of faith that there are few expectations left for changes in the short rate in 9 or 10 years' time, then most of the observed steepness in the long end of the Eurodollar futures curve can be attributed to the term risk premium. The chart below illustrates the expected risk premium from our yield curve fit and from futures markets (the difference between the 10-year and 9-year Eurodollar futures contracts). As you can see, the futures term premium has averaged 12 bps over the past 19 years, very close to both the historical estimate and theoretical yield curve fit estimate.

TIME SERIES OF EXPECTED TERM RISK PREMIUM



Source: PGIM Fixed Income and Bloomberg as of March 31, 2017.

Although both the yield curve fit and real-world methods take different approaches to estimating the current term premium, it is reassuring to see that both the level and mean of each time series have been similar over time.

The Term Risk Premium is Persistently Positive

The three approaches described above all produce a similar estimate of the term premium at the long end of the curve in the region of 10-15 bps per unit of duration. In isolation, each piece of analysis may not be enough for a high conviction answer. But together, they make a strong argument for a persistent, positive term premium.

Below we walk through an example of how to estimate the expected cost of mismatching duration using this assumption for the term risk premium. The example is based on a sample pension plan with a liability duration of 12 years, funded status of 80%, and growth asset/long-maturity bond allocation of 60%/40%. The worksheet that follows on page 6 can be used to estimate your own plan's cost to funded status of mismatching duration.

Step 1: Estimate the INTEREST RATE HEDGE RATIO

A rough estimate of a plan's interest rate hedge ratio can be calculated as follows:

= Funded status * % allocation to fixed income * fixed income duration / liability duration

= 80% * 40% * 15 years / 12 years

= 40% interest rate hedge ratio

A 40% interest rate hedge ratio is typical for a plan early on the glidepath. The longer duration of the fixed income market benchmark (Long Government Credit Index in this instance) helps to increase the hedge ratio.

Step 2: Estimate the INTEREST RATE CONTRIBUTION TO FUNDED STATUS VOLATILITY

The interest rate hedge ratio allows us to estimate how much volatility in the funded status comes from liability duration mismatch, using the calculation below:

= (|1 – interest rate hedge ratio|) * liability duration * interest rate volatility[5]

= (|1 – 40%|) * 12 years * 0.8%

= 5.8% interest rate contribution to funded status volatility

The interest rate mismatch creates **almost 6% volatility in funded status** because 60% of the 12 years of liability duration is unhedged.

Step 3: Estimate the EXPECTED CHANGE IN FUNDED STATUS

Since the sample plan is short duration, it is also short the term risk premium. Over the long-term, being short this risk premium is expected to reduce the plan's funded status. We can estimate the expected contribution to change in funded status as follows:

= (interest rate hedge ratio – 1) * liability duration * term risk premium[6]

= (40% – 1) * 12 years * 0.15%

= – 1.1% expected reduction in funded status

The cost to this plan of mismatching duration is expected to be **– 1.1% of funded status annually.**

Step 4: Estimate the INFORMATION RATIO OF MISMATCHING DURATION

Information ratio is a risk-adjusted measure of return which allows us to compare the efficiency of different uses of risk budget. The information ratio of the sample plan's duration mismatch is estimated below:

= Expected change in funded status from mismatch / interest rate volatility from mismatch

= – 1.1% / 5.8%

= – 0.19 information ratio

The **negative (-0.19) information ratio** shows that mismatching duration is a poor use of strategic risk budget. Over the long term, risks with negative information ratios are expected to lose value.

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[5] Pension liabilities are most sensitive to the long end of the curve where interest rate volatility is ~80 bps annually.
[6] We use an assumption of 0.15% of risk premium per unit of duration.

How Much is the Term Premium Costing You?

STEP 1: Estimate the INTEREST RATE HEDGE RATIO

= Funded status * % allocation to fixed income * fixed income duration / liability duration

= 80% * 40% * 15 years / 12 years

%	*	%	*	yrs	/	yrs	
Funded Status		*% Allocation to FI*		*FI Duration*		*Liability Duration*	

= 40% interest rate hedge ratio

%
IR Hedge Ratio

STEP 2: Estimate the INTEREST RATE CONTRIBUTION TO FUNDED STATUS VOLATILITY

= (|1 – interest rate hedge ratio|) * liability duration * interest rate yield volatility[7]

= (|1 – 40%|) * 12 years * 0.8%

(|1 – %|)	*	yrs	*	%
Interest Rate Hedge Ratio		*Liability Duration*		*Interest Rate Yield Volatility*

= 5.8% interest rate contribution to funded status volatility

%
Interest Rate Contribution to Funded Status Volatility

STEP 3: Estimate the EXPECTED CHANGE IN FUNDED STATUS

= (interest rate hedge ratio – 1) * liability duration * term risk premium[8]

= (40% – 1) * 12 years * 0.15%

(% – 1)	*	yrs	*	%
Interest Rate Hedge Ratio		*Liability Duration*		*Term Risk Premium*

= – 1.1% expected reduction in funded status

%
Expected Change in Funded Status

STEP 4: Estimate the INFORMATION RATIO OF MISMATCHING DURATION

= Expected change in funded status from mismatch / interest rate contribution to funded status volatility

= – 1.1% / 5.8%

%	/	%
Expected Change in Funded Status		*Interest Rate Contribution to Funded Status Volatility*

= – 0.19 information ratio

Information Ratio

[7] *Pension liabilities are most sensitive to the long end of the curve where interest rate yield volatility is ~80 bps annually*
[8] *We use an assumption of 0.15% of risk premium per unit of duration*

Hiding and Seeking

By valuing pension liabilities with the yield curve, there is an implicit assumption for the term risk premium included in every asset-liability study. It might just be hiding. Or, unknowingly, it might just be assumed to be zero. Without a good understanding of how large or small the risk premium is, it is difficult to assess the expected return of being short duration.

The 'Neutral' Hedge Ratio

If our estimate of the expected term premium were 0 bps, duration mismatch would simply be an uncompensated risk and we would recommend hedging 100% of the plan's interest rate risk (in the absence of a tactical view on rates). In fact, since the term premium is usually positive, it could be argued that the neutral hedge ratio should be *higher* than 100%.

Being long the term risk premium would also have helped funded status during the past two recessions. When stocks performed poorly, rates also fell and substantially increased liability values. Being long duration would have cushioned the hit to funded status.

Increasing the Hedge Ratio

We expect most underfunded plans to continue holding significant growth allocations—there are both economic and accounting incentives to do so. Given this competing objective, however, many pension plans have struggled to meaningfully increase their interest rate hedge ratios. If the growth allocation limits the assets available to reduce interest rate risk, plans should consider selecting fixed income securities that maximize duration extension. The first step in this direction is ensuring that the fixed income duration has been extended from the Aggregate Index—moving to either a Long Corporate or a Long Government Credit strategy. After that, U.S. Treasury STRIPS and interest rate derivatives are among the most efficient ways of increasing the hedge ratio per dollar invested. Collateral to back an interest rate overlay can be sourced from the U.S. Treasuries within a Long Government Credit mandate or can be funded with a standalone U.S. Treasury or STRIPS mandate.

Conclusion

The term risk premium is persistently positive. Pension plans are persistently short duration. This is not a good combination. Over the long term, we estimate that the typical U.S. pension plan is expected to lose around 1% in funded status per year from mismatching duration. Plan sponsors preparing for an asset-liability study should find out whether an explicit term risk premium assumption is being made—or if an implicit assumption is hiding away somewhere. We recommend plan sponsors consider all options available to reduce interest rate risk and remove this significant, but often hidden, expected cost to funded status.

NOTICE: IMPORTANT INFORMATION

Source(s) of data (unless otherwise noted): PGIM Fixed Income as of May 2017.

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