Best Way to Duration Match Pension Liabilities?

Cash Flow Matching

by
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Pension liabilities behave like bonds and are very interest rate sensitive. The present value (PV) of liabilities is extremely affected by the discount rate(s) used to price liabilities. Since the pension funded ratio and funded status are present value (PV) calculations, anything that affects the PV of liabilities is the concern of LDI or immunization. To immunize the pension against this interest rate risk and sensitivity LDI uses several approaches with the main focus on duration matching liabilities. LDI may use interest rate swaps, futures, derivatives, risk overlays, etc. to assist in duration matching liabilities. They are all hedging tools to help assets match the liability growth rate. **However, they do not match or fund the liability cash flows.** Duration matching (DM) has several difficult, if not erroneous, data gathering choices it uses:

1. **Average duration of liabilities**
   Where do you get the average duration of liabilities? Most, if not all, actuarial reports do not provide this calculation. Moreover, they do not provide the projected liability benefit payment schedule which you would need to calculate duration. In addition, actuarial reports are annual reports usually three to six months delinquent so there would be serious delayed information. The duration calculation is a present value calculation (not future value) at a precise moment in time… like a balance sheet. As time and interest rates change, so will duration. Moreover, current assets are funding *net liabilities after contributions* which is not calculated by the actuary. Only a ***Custom Liability Index (CLI)*** based on each pension's unique projected benefit payment schedule and projected contributions could provide an accurate and monthly projected benefit payment schedule and duration profile. I created a research paper a while ago titled… **Pension Confusion: The Problem with Averages**.

2. **Discount Rates**
   Since the duration of liabilities changes with interest rates (discount rates) this calculation needs to be refreshed and updated on a frequent and accurate basis. According to pension accounting rules (ASC 715 (FAS 158), GASB 67/68) and federal funding standards (PPA – MAP 21 and spot rates) there is an assortment of discount rates required to price liabilities. Which one to use and what source are you using could create several discount rate variations. If a generic bond index is used as a liability proxy, there are more difficulties. **There is no bond index that uses any of the required pension accounting discount**

rates… they use market rates! The yield and duration difference could be a serious mismatch. Any difference in yield creates a difference in the calculation of duration and liability growth rates. Only a custom liability index (CLI) benchmark using market discount rates (ASC 715) could provide an accurate duration and liability growth rate calculation.

3. **Generic Bond Indexes**

A common proxy for the average duration of liabilities is to use a generic bond market index… usually the Bloomberg Barclay's long corporate index. Such a proxy creates several erroneous data issues. This index has no bonds shorter than 10 years and no durations longer than 19 years although heavily skewed to long coupon bonds. This certainly does not represent any pension liability schedule even if the average durations were similar. Accounting standards and actuarial practices price liabilities as a portfolio of zero-coupon bonds with a single average discount rate to calculate the present value of this zero-coupon liability portfolio. **Please note there are no generic bond indexes that use zero-coupon bonds as their portfolio. Also, there are no generic bond indexes that use pension discount rates in accordance with FASB, GASB and PPA guidelines.** Every pension plan's liabilities are different and unique to that plan due to different labor force, salaries, mortality and plan amendments. There is no way any generic bond market index could represent any pension plan liability term structure. Only a custom liability index benchmark could properly represent and measure any pension plan's liabilities providing all of the critical data calculations needed to de-risk the plan.

4. **Bond Math… the Flaws of Duration**

The duration calculation has been around for a long time originally formulated by Frederick R. Macaulay in 1938 as a way to measure a bond's average life. Duration is defined as the average life of a bond's cash flow in present value dollars. Over time it became used as a price sensitivity tool by modifying duration = duration of bond/(1 + yield/n). N is the number of periodic interest payments per year. Unfortunately, modified duration has very limited use as an indicator of interest rate sensitivity. Bond math proves the following inconsistencies and dangers of using duration matching as a way to match price or interest rate sensitivity:

A. "**Proportionality** = twice the duration does not produce twice the total return. Duration only measures price sensitivity and not income returns.
B. **Same Duration** = Even if you match durations, if you don't match income returns you won't match total returns.
C. **Time** = duration is a present value calculation and changes with time so the ending duration will be different that the beginning duration. The longer the time

horizon the more variance in duration. Over time the same duration zero-coupon bond (liabilities) and coupon bond will diverge on their ending duration.

D. **Maximum Duration** = duration actually peaks out at high yields such that an extension of maturity will shorten duration.

E. **Large Yield Moves** = Modified duration times large yield moves results in large price return mismatches. The larger the yield move the larger the error.

F. **Spot Calculation** = Duration is a PV calculation only good for a one-day horizon. Every day forward, duration should change especially on zero-coupon bonds.

G. Averages = Using portfolio average durations gives totally inaccurate information. Duration is a function of coupon, yield and maturity. If any one of these features is distorted, future duration changes will be distorted. The problem here is that bond math is not linear such that a six-year bond will not exhibit the same price sensitivity as a portfolio of equally weighted two and ten-year duration bonds.

5. Interest Rate Sensitivity

For every-one year of duration difference between the liability proxy and the actual duration of each plan's benefit payment schedule would represent a 1% mismatch in liability growth for every 100 bps of discount rate change. In truth, the duration mismatch is more likely to be three to five years rather than one year. Given that pension cost for the actuary, administration, asset managers and consultant are usually less than 1% a year; such a duration mismatch could be very costly representing years of pension cost. Moreover, most duration matching strategies are heavily skewed to maturities longer than 10-years. This makes the duration matching strategy extremely interest rate sensitive.

6. Funding Liabilities

Imagine a 12-year average duration liability benefit payment schedule. It could have many different term structure shapes to come up with an average 12-year average duration. Imagine 100% of the assets in a 12-year duration bond portfolio. If interest rates rose 50 basis points in a year, assets and liabilities supposedly would both have a -6% price return (interest rate movement x duration (as a negative number)). If they had the same income return = 4% they would match again (note that assets usually don't match the income or yield of liabilities). However, if the duration matching assets are used to ***fund*** liabilities then a -2% loss (-6% + 4% = -2%) on assets could be funding a one-year liability which should have a small positive growth rate. So, the assets could be taking a loss each year to fund the next year's liability benefit payments if interest rates continue to rise. This could get to be a serious costly mismatch if interest rates began a secular trend to higher rates for the next five years. But the point is…there is no cash flow match here, only a duration match so there is both a funding and interest rate risk!

7. **Derivatives**

   Interest rate swaps and futures are contracts not true nominal assets. There is no cash flow or funds available to make the liability cash flow payments. They are hedges vs. the liability growth rate. In fact, these strategies introduce new risk: counter party risk, interest rate risk, non-matching risk of assets purchased (usually equities) vs. liabilities and leverage. In addition, interest rate swaps and futures have all of the problems associated with a liability proxy data gathering… as listed with duration matching.

Future Value vs. Present Value

"Actuarial practices use present values (PV) to calculate the pension funded ratio and funded status. But pension benefit payments are future values (FV). This suggests that the future value of assets vs. the future value of liabilities is the most critical evaluation. But most asset classes are difficult to ascertain their future value. This is why the present value (PV) is used to calculate the funded status. Only bonds (and insurance annuities) have a known future value and have historically been used to cash flow match liabilities (i.e. defeasance, dedication). To prove my point as to the potential misinformation with using a PV calculation, let's use a simple example below. Two pensions both at $100 million market value would have the same funded ratio in PV$. But pension B is 100% invested in corporate bonds that out yield pension A (100% invested in Treasuries) by 100 bps per year. Certainly, plan B has a much greater future value (@ 20% higher) and funded status if we used future values. This suggests that the funded ratio and funded status may not be that accurate or even good indicators of the true economic solvency of a pension plan:

Pension	Composition	YTM	PV	FV
A	100% Treasuries	4.00%	$100 million	$250 million
B	100% Corporates	5.00%	$100 million	$300 million

Solution: Cash Flow Matching (CFM)

The point of all this is that we need to focus more on the FV of assets vs. liabilities. This is what cash flow matching (CFM) is all about. It is matching and funding future values (projected benefit payments - contributions). If we present value liabilities at market rates, they will have discount rates of AA corporates (FASB method) or perhaps, U.S. Treasury STRIPS (defeasance method). A corporate bond portfolio matched to liabilities that out yield's liabilities would **enhance the funded ratio on a future value basis thereby reducing funding costs**. Moreover, using bond math accurately, a cash flow matched portfolio skewed to longer maturities reduces funding costs. This is why cash flow matching of liability future values is the most prudent lowest risk and lowest

cost methodology to de-risking a pension through asset liability management (ALM)."[1] In the 1960s through the 1980s, CFM was called Dedication because the asset cash flows were matched and dedicated to funding liability cash flows. Dedication was the most appropriate and cost-effective way to fully fund pension liabilities.

Interest Rate Risk

The systematic risk of bonds is their interest rate sensitivity. The longer the maturity and duration of any bond portfolio supposedly the higher the interest rate risk. But since cash flow matching is focused on funding projected benefits (future values) as a term structure, interest rate risk has been neutralized or eliminated. A byproduct of CFM is duration matching. By funding monthly liability cash flows CFM will duration match each benefit payment. Given a 30-year liability schedule, CFM will duration match 360 points along the liability term schedule. This is in sharp contrast to duration matching that at best will attempt to match 7 key duration spots along the liability benefit payment schedule or yield curve. Any liability schedule is a term structure and yield curve. You have to replicate the term structure not an average duration to match or immunize liability cash flows. This is a tedious process and requires accurate calculations and trades to be successful.

Please note that **future benefit payments are not interest rate sensitive**. As a result, a cash flow matched portfolio is not concerned about interest rates except for any reinvestment of excess cash flows. In contrast to active bond management where higher interest rates are bad in that they deteriorate bond prices, with CFM higher interest rates are good allowing the cash flow matched portfolio to reinvest at higher interest rates and lower costs. Mitigating interest rate risk is a major benefit of CFM.

"Where is the knowledge we have lost in information"
T.S. Eliot

[1] Ryan ALM, Inc. (2019), Pension Confusion: Present Value vs. Future Value