



## Pension Confusion: The Problem with Averages

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Most pension have assets managed to generic market index benchmarks and/or liabilities. In both cases, the focus of these assets is to match or beat some average (i.e., duration, total return, YTM). Unfortunately, few understand how these averages can be misleading if not erroneous.

### Liabilities (Duration Matching)

Duration matching is a common LDI strategy for pensions where the plan sponsor looks to immunize their bond portfolio versus the interest rate sensitivity of the liabilities they are funding. To achieve this interest rate immunization, the strategy is to match the average duration of the liabilities. There are at least four problems here:

1. The actuary does not provide the average duration of projected benefits.
2. The actuarial report usually comes out annually... months after the fiscal year. Duration is a present value calculation that changes with interest rates and time, both of which change daily.
3. Assets do **not** fund gross projected benefits. They fund **net benefits after contributions**. This net liability is not calculated by the actuary which can be much different than the gross liability in dollars and duration especially for Corporate and Public pension plans that have a high contribution rate. Pension assets need to know what they are funding. The economic reality is... assets are funding net liabilities after contributions!
4. Duration is a present value calculation based on a discount rate yield curve. ASC 715 is the most prominent and acceptable for corporate and multiemployer pension plans. Moreover, Moody's has adopted ASC 715 discount rates to assess municipal credits instead of the ROA discount rate commonly used under GASB accounting. FASB requires that this ASC 715 discount rate yield curve be converted to a single rate average discount rate. The duration of this single discount rate is certainly different than the average of a multiple discount rate yield curve. In the sample liability term structure shown on the next page priced with ASC 715 discount rates, we calculate:



	<b>ASC 715 Yield Curve</b>	<b>Single Rate</b>	<b>Difference</b>
Average Yield	2.29%	2.72%	0.43%
Duration	13.84 years	14.34 years	0.50 years

Note: For an accurate immunization, you need to match the duration of the ASC 715 yield curve (all liabilities) not the single rate average duration.

### ASC 715 (FAS 158) Discount Rates

June 30, 2021

Payment Date	Benefit Payment	%	Term/WAL	Rate (%)	PV(\$)	%	Weighted Dur	Rate (%)	Discount Rate PV(\$)	%	Weighted Dur
12/31/2022	23,352,133	2.335	1.504	0.410	23,208,749	3.487	0.052	2.723	22,427,332	3.369	0.051
12/31/2023	24,012,209	2.401	2.504	0.672	23,613,018	3.548	0.089	2.723	22,449,930	3.373	0.084
12/31/2024	24,888,739	2.489	3.504	0.915	24,106,778	3.622	0.127	2.723	22,652,576	3.403	0.119
12/31/2025	26,342,921	2.634	4.504	1.142	25,029,735	3.760	0.169	2.723	23,340,516	3.507	0.158
12/31/2026	27,977,378	2.798	5.504	1.352	25,983,264	3.904	0.215	2.723	24,131,557	3.626	0.200
12/31/2027	29,770,530	2.977	6.504	1.548	26,939,564	4.047	0.263	2.723	24,997,508	3.756	0.244
12/31/2028	31,575,597	3.158	7.504	1.730	27,763,098	4.171	0.313	2.723	25,810,329	3.878	0.291
12/31/2029	33,591,569	3.359	8.504	1.897	28,629,606	4.301	0.366	2.723	26,730,315	4.016	0.342
12/31/2030	35,706,561	3.571	9.504	2.052	29,438,099	4.423	0.420	2.723	27,660,093	4.156	0.395
12/31/2031	38,159,588	3.816	10.504	2.194	30,380,349	4.564	0.479	2.723	28,776,708	4.323	0.454
12/31/2032	40,544,965	4.054	11.504	2.324	31,127,083	4.677	0.538	2.723	29,765,020	4.472	0.514
12/31/2033	42,370,626	4.237	12.504	2.443	31,332,160	4.707	0.589	2.723	30,280,703	4.549	0.569
12/31/2034	42,416,091	4.242	13.504	2.551	30,186,316	4.535	0.612	2.723	29,509,614	4.434	0.599
12/31/2035	42,170,534	4.217	14.504	2.648	28,865,775	4.337	0.629	2.723	28,561,026	4.291	0.622
12/31/2036	41,978,233	4.198	15.504	2.735	27,627,139	4.151	0.644	2.723	27,677,106	4.158	0.645
12/31/2037	41,562,094	4.156	16.504	2.813	26,295,613	3.951	0.652	2.723	26,676,310	4.008	0.661
12/31/2038	40,798,902	4.080	17.504	2.881	24,815,876	3.728	0.653	2.723	25,492,278	3.830	0.670
12/31/2039	39,927,139	3.993	18.504	2.941	23,352,891	3.509	0.649	2.723	24,286,234	3.649	0.675
12/31/2040	38,994,866	3.899	19.504	2.993	21,939,758	3.296	0.643	2.723	23,090,388	3.469	0.677
12/31/2041	38,001,518	3.800	20.504	3.037	20,577,459	3.092	0.634	2.723	21,905,671	3.291	0.675
12/31/2042	36,744,213	3.674	21.504	3.074	19,160,354	2.879	0.619	2.723	20,619,417	3.098	0.666
12/31/2043	35,274,219	3.527	22.504	3.105	17,724,896	2.663	0.599	2.723	19,269,776	2.895	0.652
12/31/2044	33,850,576	3.385	23.504	3.131	16,402,528	2.464	0.579	2.723	18,001,850	2.705	0.636
12/31/2045	32,222,513	3.222	24.504	3.151	15,067,302	2.264	0.555	2.723	16,681,777	2.506	0.614
12/31/2046	30,569,989	3.057	25.504	3.166	13,804,148	2.074	0.529	2.723	15,406,714	2.315	0.590
12/31/2047	28,872,283	2.887	26.504	3.178	12,598,583	1.893	0.502	2.723	14,165,362	2.128	0.564
12/31/2048	27,170,060	2.717	27.504	3.187	11,463,425	1.722	0.474	2.723	12,976,840	1.950	0.536
12/31/2049	25,500,348	2.550	28.504	3.194	10,407,976	1.564	0.446	2.723	11,856,494	1.781	0.508
12/31/2050	23,714,474	2.371	29.504	3.199	9,366,728	1.407	0.415	2.723	10,733,849	1.613	0.476
12/31/2051	21,939,133	2.194	30.504	3.200	8,392,059	1.261	0.385	2.723	9,667,035	1.452	0.443
<b>Total</b>	<b>1,000,000,000</b>	<b>100.000</b>	<b>15.979</b>	<b>2.292</b>	<b>665,600,331</b>	<b>100.000</b>	<b>13.838</b>	<b>2.723</b>	<b>665,600,331</b>	<b>100.000</b>	<b>14.330</b>



### **Solution: \$ Duration Matching with Modified Duration**

Maturity is an indicator of interest rate risk because longer maturity bonds move more in price than shorter maturity bonds given a change in yield. However, maturity is not a good measure of interest rate risk because maturity only considers the timing of the final principal cash flow at maturity and ignores the sizes and timing of all the other cash flows leading up to maturity.

The present value or price volatility of pension liabilities behaves just like bonds. A pension liability schedule is a term structure or yield curve of ASC 715 rates. Therefore, the interest rate risk in a pension liabilities schedule (actuarial projected benefits) can be matched with a portfolio of bonds.

A better measure for interest rate risk in the form of price sensitivity is called **Modified Duration**. Modified Duration considers all the bonds cash flows and is the weighted average time to receipt of all the cash flows, with the weights being the present values of the cash flows divided by a factor of  $(1+Y)$  where  $Y$  is the annual yield to maturity of the bond.

Modified Duration represents the percentage price change in market value in response to a change in the asset or liability yield. By weighting modified duration by the market value of the holding, that is, by multiplying the market value of the position by its modified duration, we get *dollar-weighted duration*. This dollar-weighted duration is known as Dollar Duration and represents the actual dollar change in market value for a bond given a change in its yield. Dollar duration is typically expressed in the dollar value change per one basis point change in yield (DV01).

The major advantages of using dollar duration are that it is additive and better suited for asset liability management. Dollar duration extends easily from individual securities to entire portfolios. The dollar duration of a portfolio is simply the sum of the dollar durations of all the individual holdings. The dollar duration of a bond portfolio can be matched to the dollar duration of pension liabilities. Bond durations cap out around 20-years so for liabilities with durations longer than 20-years it is not possible to match duration but... **it is possible to match the Dollar duration of liabilities with durations longer than 20-years**. Therefore, Dollar duration is very useful in asset liability management for liability driven investors such as defined benefit pension plans.



Ryan ALM uses dollar duration matching to help reduce pension volatility as defined as the dollar value difference in interest rate sensitivity between the present value of assets and liabilities. Ryan ALM starts by creating a *Custom Liability Index (CLI)* for each pension client. The Custom Liability Index is derived from the unique liabilities cash flow schedule provided by the plan actuary. The CLI measures and monitors the change in present value for the liabilities given a change in ASC 715 discount rates and is the proper benchmark for a plan sponsor and their liability driven investor(s).

Once we have determined the interest rate risk in the liabilities, the next step is to ensure that the bond portfolio has the same amount of interest rate risk as liabilities in order to reduce volatility between the present value of assets and liabilities. Ryan ALM builds a bond portfolio called the **Liability Beta Portfolio (LBP)** that matches the cash flows of the bonds to the liability cash flows (benefit payments). Since dollar duration is additive, we can set the dollar duration of the bond portfolio equal to the dollar duration of liabilities. Ryan ALM believes that cash flow matching liabilities with bond cash flows along with the use of dollar duration is a lower cost and lower volatility approach to pension asset liability management. It is certainly more accurate than traditional duration matching to immunize interest rate sensitivity.