

Viewpoints

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LDI: Not One Magic Bullet

By Rene Martel

*When it comes to liability-driven investing (LDI), the learning curve of all parties involved – actuaries, investment consultants, investment managers and plan sponsors – has been pretty steep over the last few years. With better understanding and knowledge, there is now a broader recognition that LDI is not a product. Instead, more and more people accept LDI as a process or framework to assess the risk position of defined benefit plans **relative to their liabilities** in order to identify the investment strategy that is best suited to the sponsor's objectives. The corollary is that no one-size-fits-all strategy or product can address the wide spectrum of specific problems and issues faced by plan sponsors. The strategy must be tailored to a certain extent to the unique nature and profile of the liabilities and, **more importantly, to the specific objectives and risk tolerances of the plan sponsor.***

The first step for any investor seeking to employ an LDI strategy is to get as clear a definition of objectives and risk tolerances as possible. The optimal strategy will depend to a large degree on those objectives. But defining intangible targets like risk tolerances is no easy task. A good starting point to get a better handle on the sponsor's risk/return sweet spot is to quantify the current risk position and the potential risk reduction benefits, costs and limitations of different strategies. This will enable plan sponsors to appreciate the tradeoffs and make informed decisions.

In order to assess the surplus risk position of the plan and the potential benefits of different LDI strategies, this article focuses on two risk measures. First, we look at a one-standard-deviation event of surplus risk (illustrated in Chart 1). This is often referred to as tracking error to liabilities or surplus volatility. For example, a tracking error to liabilities of 10 percent means that there is approximately a one in three chance that the funding ratio changes *by more than* 10 percent in any one year (i.e., a fully funded plan would have a one in three chance of seeing its funding ratio fall below 90% or rise above 110% over the year). As we have yet to find very many sponsors who are overly concerned by a potential *increase* of 10 percent or more in funded status, the one-standard-deviation risk is essentially the one in six chance that the funding ratio falls by 10 percent or more in any one year.

In this world where the 100-year flood seems to happen every five years, it is also a good idea to assess tail risk or "catastrophic" event severity. For this purpose, we will calculate the 95th percentile surplus value-at-risk of the different strategies (illustrated in Chart 2). This measure will enable us to quantify the downside of a one in 20 event. For example, a 95th percentile surplus value-at-risk of 18 percent means that there is approximately a one in 20 chance that the funding ratio decreases *by more than* 18 percent in any one year.

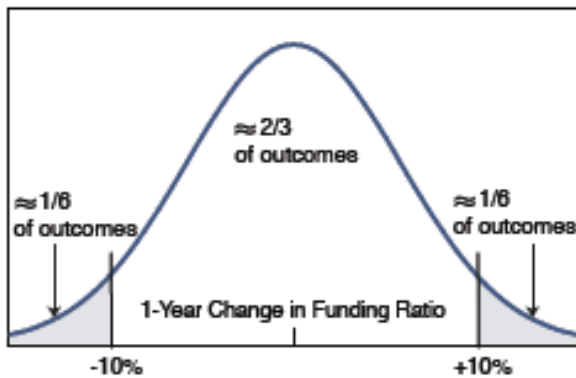
Finally, we will also keep track of asset-only volatility as measured by the standard deviation of asset returns. The volatility of variables that really matter to plan sponsors,

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such as contributions, pension expense and funding position, is driven by surplus risk and is not affected much by asset-only risk. However, excessive leverage – through the use of large duration overlays, for example – can lead to unhealthy levels of asset-only volatility and may create operational issues from an asset management standpoint.

**Tracking Error to Liabilities = 10%
(1-Standard Deviation Event)**



Source: PIMCO

- Assumes that surplus changes are normally distributed.
- Assumes no benefit accruals, benefit payments, or contributions.

Hypothetical Example for illustrative purposes only.

Chart 1

**95th Percentile Surplus Value-at-Risk = 18%
(1 in 20 Event)**

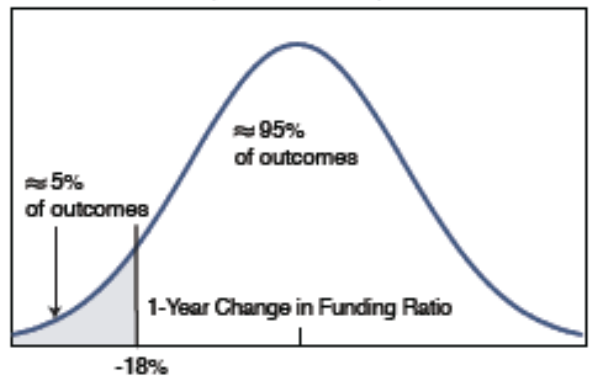


Chart 2

Part 1: Comparing Different LDI Strategies

We will use a case study to illustrate the benefits and limitations of different LDI strategies. Let's assume that we are looking at a "typical" plan – if such a thing exists – with a liability duration of 12 years and a 100 percent funding ratio.

Our hypothetical plan asset allocation is as follows:

- 65 percent equities (2/3 S&P 500 and 1/3 MSCI EAFE*)
- 35 percent fixed income (Lehman Brothers Aggregate Index (LBAG))

* Morgan Stanley Capital International Europe, Australasia, Far East Index

As Table 1 shows, with such an asset allocation the plan sponsor faces a one in six chance that the funding ratio could fall by 11.1 percent or more in any one year (i.e., a one in six chance that the plan goes from fully funded to less than 89% funded over the year). The one in 20 event tail risk is a drop of 19.1 percent or more in funded status. For most sponsors who were accustomed to living in the asset-only world, this is a riskier position than expected when compared to how they traditionally have measured risk.

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Initial Risk Position

Strategy	Fixed Income Allocation	Fixed Income Duration	Total Assets Duration	Duration Coverage	Estimated Tracking Error to Liabilities (1-Std-Dev Risk)	Estimated 95 th Percentile Surplus Value-at-Risk (1 in 20 Risk)	Estimated Asset-Only Volatility (1-Std-Dev Risk)	Estimated Expected Return ¹
Initial Asset Allocation 65% Eq. / 35% F.I. (LBAG)*	35%	4.8	1.7	14%	11.1%	19.1%	10.0%	7.0%

Source: PIMCO

Hypothetical example for illustrative purposes only.

Note: Underlying assumptions are provided in the Appendix.

* Equity is represented by 2/3 S&P 500 and 1/3 MSCI EAFE, and fixed income is represented by Lehman Brothers U.S. Aggregate Bond Index (LBAG).

Table 1

Simple Duration Extension

The first question most clients ask when they appreciate the magnitude of the asset-liability mismatch is: "How can we reduce surplus risk without sacrificing too much long-term expected return or making large-scale asset allocation changes?" The answer can be found by comparing the risk characteristics of their current fixed income allocation to those of their liabilities. The Lehman Brothers Aggregate Bond Index has an intermediate duration, a large share of its interest rate risk exposure to the first 10 years of maturity and a low or negative convexity.² On the other side, liabilities generally have a long duration, the bulk of their interest rate risk exposure to maturities beyond 10 years and relatively high convexity. Therefore, the low-hanging fruit in terms of risk reduction is to invest the existing fixed income allocation in a portfolio with risk characteristics that are more consistent with liabilities. For example, the sponsor could move the fixed income allocation from a Lehman Brothers Aggregate benchmark to a longer duration benchmark. This benchmark could either be a broad long duration index like the Lehman Long Government/Credit Index or a customized benchmark for clients seeking a tighter match to liabilities.

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Solution #1: Simple Duration Extension
Change in Risk Profile

Strategy	Fixed Income Allocation	Fixed Income Duration	Total Assets Duration	Duration Coverage	Estimated Tracking Error to Liabilities (1-Std-Dev Risk)	Estimated 95 th Percentile Surplus Value-at-Risk (1 in 20 Risk)	Estimated Asset-Only Volatility (1-Std-Dev Risk)	Estimated Expected Return
Initial Asset Allocation 65% Eq. / 35% F.I. (LBAG)*	35%	4.8	1.7	14%	11.1%	19.1%	10.0%	7.0%
Sol. #1: Extend F.I. Duration 65% Eq. / 35% F.I. (LLGC)*	35%	11.1	3.9	32%	10.1%	17.5%	10.4%	7.3%
Change in Risk Profile (vs. Initial Asset Allocation)	0%	+6.3	+2.2	+18%	-1.0%	-1.6%	+0.4%	+0.3%

Source: PIMCO

Hypothetical example for illustrative purposes only.

Note: Underlying assumptions are provided in the Appendix.

* Equity is represented by 2/3 S&P 500 and 1/3 MSCI EAFE, and fixed income is represented by Lehman Brothers U.S. Aggregate Bond Index (LBAG) or Lehman Brothers Long-Term Government/Credit Index (LLGC).

Table 2

This shift in fixed income duration will reduce surplus risk, but generally not to the extent that most sponsors would expect. For example, the tracking error to liabilities of our hypothetical pension plan would decrease by approximately 1 percentage point (from 11.1 percent to 10.1 percent) as shown in Table 2.

The explanation for the limited risk reduction benefits here is twofold. First, by investing the bond allocation in a long duration portfolio we have essentially “immunized” only approximately 35 percent of the interest rate risk – given the 35 percent fixed income allocation. Second, at 65 percent of the total, the allocation to risk assets dominates the surplus risk contribution. In other words, the share of risk coming from the interest rate sensitivity mismatch is smaller than the share coming from allocations to asset classes with a low correlation to liabilities (as illustrated in Chart 3).

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Initial Asset Allocation Tracking Error to Liabilities Contribution Breakdown

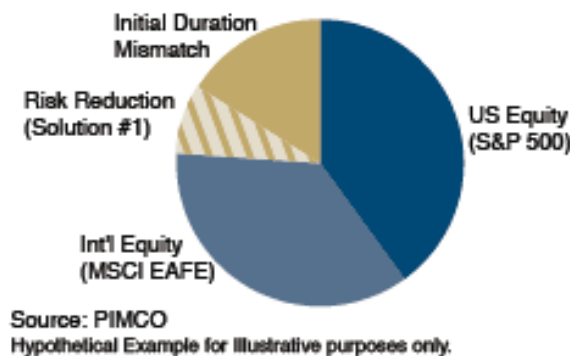


Chart 3

Many plan sponsors have made this transition despite the relatively small benefits because the risk we are attempting to eliminate here is essentially *uncompensated* risk – risk that was not providing any additional return expectations.¹ Under normal circumstances, long bonds should not return less than short/intermediate bonds over the long run³ – actually, we could argue that investors can pick up additional return by moving to long bonds when the yield curve is steep. But for this discussion, let's conservatively assume that long bonds return approximately the same as short/intermediate bonds. Therefore, we can cut down the risk exposure of the hypothetical plan by almost 10 percent (tracking error goes from 11.1 percent to 10.1 percent), without sacrificing expected return, simply by extending duration of the fixed income portfolio. This means that assuming this risk was not providing any additional return expectations, and as a result, the sponsor was not compensated for taking this risk. What was a relatively efficient portfolio in the asset-only world is much less efficient when you throw the liabilities in the mix, as shown in Chart 4. Extending duration will likely bring the portfolio closer to the efficient frontier in asset-liability space.

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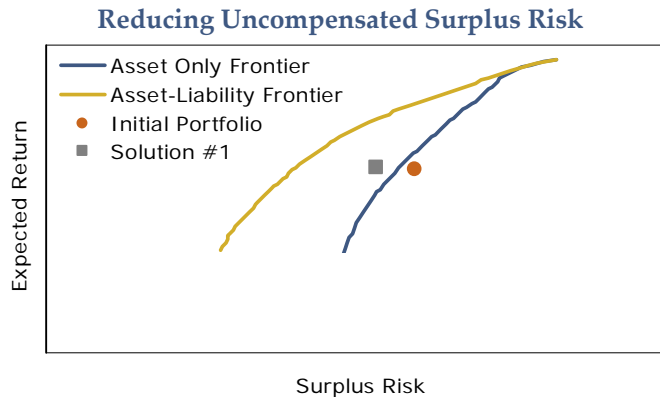


Chart 4

The natural question then is can sponsors get even more of this “free lunch” (i.e. reduction in risk relative to liabilities without decreasing the expected return on assets)? The answer is yes...to a certain extent. One approach is to implement an interest rate swap overlay on top of the fixed income portfolio in order to cover a larger share of the duration risk with the 35 percent fixed income allocation – our hypothetical Solution #2.

Duration Overlay to Further Reduce Mismatches

In our example, if we use leverage to increase the duration of the fixed income portfolio from 11 to 24 years, it is now approximately twice as volatile as the liabilities on a percentage basis – i.e., for a 100 basis points (bps) parallel shift in interest rates, the fixed income portfolio value changes by 24 percent, while the liabilities move by only 12 percent.⁴ However, since we have only 35 cents of assets in that fixed income portfolio for every dollar of liabilities, the dollar duration contribution of the fixed income portfolio plus the overlay is 8.4 years (24 years * 35 percent). As a result, for a 100 bps parallel shift in interest rates, the liabilities’ present value will change by 12 percent and the fixed income portfolio will offset 70 percent of that volatility (8.4/12.0 = 70 percent). At this point, we have significantly reduced the duration mismatch compared to the initial risk position. Indeed, as shown in Table 3, the duration risk coverage has increased from 14 percent to 70 percent.

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Solution #2: Duration Overlay to Further Reduce Mismatches
Change in Risk Profile

Strategy	Fixed Income Allocation	Fixed Income Duration	Total Assets Duration	Duration Coverage	Estimated Tracking Error to Liabilities (1-Std-Dev Risk)	Estimated 95 th Percentile Surplus Value-at-Risk (1 in 20 Risk)	Estimated Asset-Only Volatility (1-Std-Dev Risk)	Estimated Expected Return
Initial Asset Allocation 65% Eq. / 35% F.I. (LBAG)*	35%	4.8	1.7	14%	11.1%	19.1%	10.0%	7.0%
Sol. #1: Extend F.I. Duration 65% Eq. / 35% F.I. (LLGC)*	35%	11.1	3.9	32%	10.1%	17.5%	10.4%	7.3%
Sol. #2: Duration Overlay 65% Eq. / 35% F.I. (LLGC)* & Swap Overlay	35%	24.0	8.4	70%	9.0%	15.6%	12.0%	7.3%
Change in Risk Profile (vs. Initial Asset Allocation)	0%	+19.2	+6.7	+56%	-2.1%	-3.5%	+2.0%	+0.3%

Source: PIMCO

Hypothetical example for illustrative purposes only.

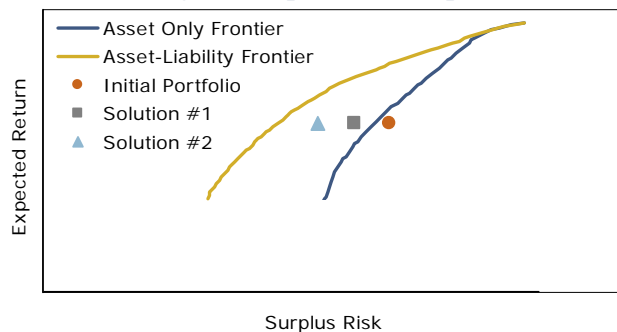
Note: Underlying assumptions are provided in the Appendix.

* Equity is represented by 2/3 S&P 500 and 1/3 MSCI EAFE, and fixed income is represented by Lehman Brothers U.S. Aggregate Bond Index (LBAG) or Lehman Brothers Long-Term Government/Credit Index (LLGC).

Table 3

With Solution #2, we may be able to cut another 1.1 percentage point from the surplus volatility (tracking error to liabilities). We're now 2.1 percentage points below the initial risk position – this means we have reduced the surplus risk exposure by almost 20% (-2.1/11.1) – and we still have not reduced expected return because we haven't changed the bond/equity mix. Therefore, we're getting even closer to that efficient frontier in asset-liability space, as shown in Chart 5.

Reducing Uncompensated Surplus Risk



Source: PIMCO

Hypothetical example for illustrative purposes only.

Chart 5

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As you may have noticed, the estimated asset-only volatility for Solution #2 is now 2 percentage points higher than in the initial allocation. This is because the long duration fixed income and overlay structure is significantly more volatile. Indeed, the duration of the structure is approximately five times that of the Lehman Brothers Aggregate Index. This means that for a given parallel shift in interest rates, the fixed income and overlay structure value will change by five times as much as that of a Lehman Brothers Aggregate portfolio.⁴ Some believe this isn't an issue because the volatility of variables that plan sponsors really care about (contributions, pension expense and funding position) is driven by surplus risk, not asset-only risk. However, it is crucial to recognize that while pension benefits are economic liabilities, they are not tradable financial liabilities. If interest rates rise sharply, liabilities may go down but they cannot be liquidated for gain. Therefore, satisfying margin collateral calls on a swap overlay when rates rise would require sponsors to liquidate financial assets to settle obligations with counterparties. If the value of the assets collateralizing the overlay declines sharply at the same time, it may mean locking in losses on that collateral pool.

In our hypothetical Solution #2, the long duration portfolio is levered approximately one time (duration is extended from 11 years to 24 years with the overlay). We consider this a reasonable amount of leverage and there will most likely be enough liquidity in the fixed income portfolio to meet the potential outflows on the swaps. Those who want to employ larger amounts of leverage should think carefully about potential collateral flows and the impact of liquidating assets in distressed market environments. In summary, duration leverage can be a useful tool, but it must be used with moderation.

Some people may ask why we cover just 70 percent of the interest rate risk with the fixed income portfolio and overlay structure in our hypothetical Solution #2 – instead of 100 percent. This is because the risk reduction benefits of duration overlays are marginally decreasing. Although we do not usually look at equities as a source of duration, there is still some correlation between equities and liabilities, albeit low. As a result, there is no need to cover 100 percent of the interest rate risk with the fixed income and overlay portfolio when you have a meaningful allocation to risk asset classes, as you will get a small amount of correlation to liabilities from those non-fixed income classes. For a 65/35 plan, the sweet spot in terms of duration coverage from the fixed income piece is generally between 65 percent and 75 percent depending on the duration of liabilities and the composition of risk asset allocations. Beyond this point, increasing duration will not materially reduce surplus risk. Therefore, there is generally no strong rationale to amplify the operational complexity and asset-only volatility with a larger overlay position. Note that as risk asset allocations decrease, the optimal coverage ratio from the fixed income portfolio increases and can reach 100 percent when the fixed income allocation approaches 100 percent.

Now our asset portfolio is more efficient in asset-liability space, as shown in Chart 5.⁵ Sponsors who are comfortable with a meaningful amount of risk because they feel they are compensated for it will generally pause here. Their objective was to eliminate uncompensated interest rate risk, and they have achieved this to a large extent.

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But for many others, a one in six chance of a 9.0 percent or more decrease in funding ratio in any one year is still too much risk. Among those, we generally find plans large enough to have a meaningful impact on the corporation's (or institution's) cash flows or financial statements, or sponsors in cyclical industries who could not afford large contribution increases during weak periods for the core business. Others may feel that their risk budget is better spent within the corporation or institution because of the asymmetry of pension surplus risk – the sponsor experiences the full brunt of the downside risk (i.e., must fund any deficit), but generally does not have a clear access to the upside when there is a significant surplus buildup (i.e., surplus ownership and tax laws will often prevent the sponsor from accessing the surplus). For these corporations or institutions, there is unfortunately no more “free lunch.” Any additional reduction in surplus risk will be accompanied by a reduction in expected return.⁶ But due to the considerations mentioned above, more and more sponsors are willing to take that reduction in return expectations in exchange for significantly lower pension risk.

Bite the Bullet: Reduce Allocations to Risk Assets

Table 4 illustrates the magnitude of the surplus risk reduction achieved by increasing the fixed income allocation to 50 percent or 75 percent, our hypothetical Solutions #3A and #3B. The risk reduction benefits are much more meaningful here compared to Solutions #1 and #2. By increasing fixed income allocation from 35 percent to 50 percent, the surplus risk is cut by almost 40 percent versus the initial position (from 11.1 percent to 6.9 percent). This comes at the cost of a reduction of approximately 10 bps in expected return compared to the initial asset allocation. If the fixed income allocation was increased even further to 75 percent, surplus risk would be only a third of the initial risk position (reduced from 11.1 percent to 3.7 percent). In this case, the expected return given up would be approximately 70 bps versus the initial asset allocation.⁷

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**Solution #3: Reduce Allocations to Risk Assets
Change in Risk Profile**

Strategy	Fixed Income Allocation	Fixed Income Duration	Total Assets Duration	Duration Coverage	Estimated Tracking Error to Liabilities (1-Std-Dev Risk)	Estimated 95 th Percentile Surplus Value-at-Risk (1 in 20 Risk)	Estimated Asset-Only Volatility (1-Std-Dev Risk)	Estimated Expected Return
Initial Asset Allocation 65% Eq. / 35% F.I. (LBAG)*	35%	4.8	1.7	14%	11.1%	19.1%	10.0%	7.0%
Sol. #1: Extend F.I. Duration 65% Eq. / 35% F.I. (LLGC)*	35%	11.1	3.9	32%	10.1%	17.5%	10.4%	7.3%
Sol. #2: Duration Overlay 65% Eq. / 35% F.I. (LLGC)* & Swap Overlay	35%	24.0	8.4	70%	9.0%	15.6%	12.0%	7.3%
Sol. #3A: Increase F.I. to 50% 50% Eq. / 50% F.I. (LLGC)* & Swap Overlay	50%	19.2	9.6	80%	6.9%	11.9%	10.8%	6.9%
Sol. #3B: Increase F.I. to 75% 25% Eq. / 75% F.I. (LLGC)* & Swap Overlay	75%	14.4	10.8	90%	3.7%	6.4%	9.3%	6.3%

Source: PIMCO

Hypothetical example for illustrative purposes only.

Note: Underlying assumptions are provided in the Appendix.

* Equity is represented by 2/3 S&P 500 and 1/3 MSCI EAFE, and fixed income is represented by Lehman Brothers U.S. Aggregate Bond Index (LBAG) or Lehman Brothers Long-Term Government/Credit Index (LLGC).

Table 4

Part 1: Conclusion

In summary, it is possible to achieve lower surplus risk levels with no sacrifice in return expectations. While the benefits are not large by any stretch of imagination, they can still be meaningful as illustrated in our Solution #2 by a reduction in tracking error to liabilities of almost 20 percent (-2.1 percent/11.1 percent). The key point here is that we are getting rid of uncompensated risk exposure that does not provide additional return expectation. In that context, it is very difficult to justify maintaining exposure to this risk from a strategic standpoint. For sponsors seeking more significant reduction in risk, the solution will likely involve a shift from risk assets to fixed income and lead to some reduction in expected return. For those investors, the optimal risk/return position may be different from one sponsor to another and will depend on many factors like plan funding status, size of plan relative to size of institution or corporation, financial strength of the sponsor and cyclicity of the core business among others. A concerted dialogue between the plan sponsor, the investment consultant, the actuary and the investment manager is generally the best way to reach the optimal solution.

Part 2: Active LDI or Passive LDI?

A number of people claim that LDI portfolios should be managed passively. Their rationale is that LDI is a risk reduction exercise and therefore it is not appropriate to take active risk in these portfolios. While this seems to make sense intuitively, we reach

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a different conclusion when we actually run the numbers: *active management on the fixed income piece can actually help reduce surplus risk*. How is that possible? This is because any alpha generated on the fixed income portfolio will enable the sponsor to achieve the same expected return with a smaller allocation to equities (or other risk assets). Given that the incremental surplus risk contribution of equities is much higher than that of active fixed income management, the reduction in risk asset allocations will help significantly reduce total risk relative to liabilities.

Active Management May Mean Lower Risk

Let's assume that a sponsor targets a 7.5 percent return. If both fixed income and equities are managed passively, this would require a 25 percent fixed income and 75 percent equity mix⁸ (see Table 5). Using the same volatility and correlation assumptions as our analysis in the previous section,⁹ the surplus volatility would then be 11.7 percent.¹⁰ On the other hand, if the fixed income portfolio is managed actively, and if the investment manager is able to deliver 100 bps of alpha¹¹ annually, then the same 7.5 percent return could be achieved with a 45 percent fixed income / 55 percent equity mix. But the tracking error to liabilities of this asset allocation is much smaller at 8.5 percent. In summary, the one-standard-deviation surplus risk can be reduced by 27 percent (-3.2 percent/11.7 percent = -27 percent) if active fixed income management can generate 100bps of alpha. This contradicts the passive management proponents who claim that passive LDI portfolios lead to lower risk levels than active portfolios.

The magnitude of risk reduction benefits will vary based on the return target and risk assets' alpha expectations, as shown in Table 5.

Risk Reduction Benefits of Active Fixed Income Management

	Return Target	Scenario #1 Passive Equity Exp. Equity Alpha = 0 bp		Scenario #2 Active Equity Exp. Equity Alpha = 100 bps		Scenario #3 Active Equity Exp. Equity Alpha = 200 bps	
		7.5%	7.0%	7.5%	7.0%	7.5%	7.0%
A Passive Fixed Income (Exp. Alpha = 0 bp)	Equity*	75%	55%	53%	38%	41%	29%
	Fixed Income*	25%	45%	47%	62%	59%	71%
	Surplus Risk**	11.7%	8.5%	8.2%	5.9%	6.3%	4.6%
B Active Fixed Income (Exp. Alpha = 100 bps)	Equity*	55%	19%	32%	10%	22%	7%
	Fixed Income*	45%	81%	68%	90%	78%	93%
	Surplus Risk**	8.5%	3.3%	5.0%	2.5%	3.6%	2.3%
% Reduction in Surplus Risk {(B-A) / A}		-27%	-62%	-39%	-58%	-43%	-49%

Source: PIMCO

Hypothetical example for illustrative purposes only.

* Equity is represented by 2/3 S&P 500 and 1/3 MSCI EAFE, and fixed income is represented by Lehman Brothers Long-Term Government/Credit Index (LLGC).

** Tracking Error to Liabilities (1-Standard-Deviation)

Note: No fees or expenses were accounted in this illustration.

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Passive Portfolios Not Necessarily a Closer Match to Liabilities

In addition, there is no guarantee that a passive portfolio will actually end up being a closer fit to a specific pension liability. This is because the pricing of pension liabilities is an artificial construct – to some extent – and the liability cash flow stream is essentially one of the actuary's best estimates as to a host of variables that go into determining expected benefits. Principal among these are mortality rates, other demographic assumptions (retirement, termination), benefit election pattern assumptions and, in some cases, expected inflation level. Each of these has some degree of uncertainty around it. *If the liabilities are measured with some estimation error, does it make sense to hedge these estimates to a (very) high degree of precision and incur the extra cost of doing so? We believe not. Especially given that once the inherent uncertainty is allowed for, the marginal contribution of active fixed income management to total surplus risk is small.*

How Passive is Passive?

Another important consideration is the credit selection bias embedded in many discounting methodologies used to value liabilities. Indeed, it seems that some discounting mechanisms do not imply completely passive management. For example, think about the accounting valuation standard that uses a discount curve (or single rate) based more or less on the universe of AA corporate bonds. In this case, a liability-hedging passive portfolio would essentially hold all the AA corporate securities included in the universe used to construct the discount curve. But what happens when a specific bond from that universe is downgraded? Generally, the increase in that bond's yield (or reduction in price) due to its downgrade does not lead to a reduction in liabilities because the bond is simply eliminated from the universe used to calculate discount rates. On the other hand, the passive portfolio constructed to hedge that discounting methodology will hold that bond – since it was part of the universe at the beginning of the period – and will therefore experience a loss due to its downgrade. In other words, a passive portfolio is likely to chronically underperform liabilities, unless downgrades or defaults never happen among the discounting universe. An astute active manager might be able to avoid the bonds most susceptible to being downgraded and minimize the negative impact of the credit selection bias. It is true that there is no guarantee that the active manager will be able to avoid all the issues that will eventually be downgraded. *On the other hand, a passive portfolio guarantees that none will be avoided.*

Part 2: Conclusion

The incremental surplus risk created by seeking higher returns is much smaller if you achieve it through active fixed income management rather than with higher equity or risk asset allocations. Therefore, an actively managed fixed income portfolio can actually help reduce risk relative to liabilities. In our view, this is especially true when you take into consideration that the incremental risk created by active management is small once you allow for the uncertainty embedded in liability projections. Consequently, we believe that the optimal implementation of LDI strategies includes active management on the fixed income portfolio.

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Mr. Martel is a vice president and product manager in the Newport Beach office. He focuses on liability driven investments, including long duration and pension plan products. Prior to joining PIMCO in 2006, he was responsible for conducting asset-liability modeling and recommending risk management strategies for pension plan sponsors at Mercer Investment Consulting. He also advised institutional clients on asset allocation, investment policy and investment manager selection. Previously, Mr. Martel was in the actuarial practice of Mercer Human Resource Consulting, advising pension plan sponsors on funding, accounting and plan design matters. He has eight years of investment experience and holds an undergraduate degree in actuarial science from Laval University. Mr. Martel also holds the Fellow of the Society of Actuaries (FSA) designation and is a CFA charterholder.

Appendix

Assumptions

	Assumed Return (Beta)	Volatility
Fixed Income – Lehman Long Gov't / Credit	5.75%	8.5%
Fixed Income – Lehman Aggregate	5.00%	4.25%
Swap Overlay (40% 10-yr / 31% 20-yr / 29% 30-yr)	N/A	9.5%
U.S. Equity – S&P 500	8.00%	16.0%
International Equity – MSCI EAFE	8.25%	16.5%
Cash – Citigroup 3-month T-Bills	2.00%	1.0%
Liabilities (12.0-yr duration)	6.75%	8.75%

Source: PIMCO

Hypothetical example for illustrative purposes only.

Return assumptions and volatility are based on historical asset class returns and liability characteristics. The assumed returns targeted are not a prediction or a projection of return. No guarantee is being made that a typical portfolio will achieve the same results and actual results may be lower.

Table 6

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Appendix, continued

Correlations

	Fixed Income – Lehman Long Gov't / Credit	Fixed Income – Lehman Aggregate	Swap Overlay (40% 10-yr / 31% 20-yr / 29% 30-yr)	U.S. Equity – S&P 500	International Equity – MSCI EAFE	Cash – Citigroup 3-month T-Bills	Liabilities (12.0-yr duration)
Fixed Income – Lehman Long Gov't / Credit	1.00	0.82	0.95	0.10	0.05	0.05	0.96
Fixed Income – Lehman Aggregate	0.82	1.00	0.81	0.15	0.05	0.15	0.82
Swap Overlay (40% 10-yr / 31% 20-yr / 29% 30-yr)	0.95	0.81	1.00	0.05	0.00	0.05	0.89
U.S. Equity – S&P 500	0.10	0.15	0.05	1.00	0.65	0.05	0.20
International Equity – MSCI EAFE	0.05	0.05	0.00	0.65	1.00	0.00	0.12
Cash – Citigroup 3-month T-Bills	0.05	0.15	0.05	0.05	0.00	1.00	0.05
Liabilities (12.0-yr duration)	0.96	0.82	0.89	0.20	0.12	0.05	1.00

Source: PIMCO

Hypothetical example for illustrative purposes only.

Sectors are represented by the following: U.S. Equity – S&P 500; International Equity – MSCI EAFE (Morgan Stanley Capital International Europe, Australasia, Far East) Index; Fixed Income – Lehman Brothers Aggregate or Lehman Long Gov't/Credit; 30-year Swap Overlay – Lehman Brothers Par Swap Index. Correlation is based on a 15-year time frame for swap overlay and 20-year time frame for the indices (as of 12/31/07); Cash – Citibank 3-Month Treasury Bill Index.

Table 7

¹ Expected return is the weighted average of the assumed return based on the respective asset allocations and is not a representation or a guarantee of future returns.

² Convexity is a second order effect. While duration is a measure of the rate of change in present value for a given variation in interest rates, convexity can be interpreted as the rate of change of duration for a given variation in interest rates.

³ Unless the yield curve is inverted.

⁴ Ignoring convexity effects.

⁵ Further risk reduction could be achieved by better diversifying the risk asset allocations (i.e., alternatives, commodities and other diversifiers).

⁶ Here we are ignoring the additional risk reduction that could be achieved by better diversifying risk assets.

⁷ Assuming no credit for active management of fixed income in the expected return calculation.

⁸ We use the same assumptions as in the previous section. We assume that the equity allocation is split 2/3 U.S. equities and 1/3 international equities.

⁹ See appendix for complete list of assumptions.

¹⁰ Tracking error to liabilities (1-standard-deviation).

¹¹ Alpha is the excess return relative to the benchmark.

Past performance is not a guarantee or a reliable indicator of future results. Investing in the bond market is subject to certain risks including market, interest-rate, issuer, credit, and inflation risk. Equities may decline in value due to both real and perceived general market, economic, and industry conditions. Derivatives may involve certain costs and risks such as liquidity, interest rate, market, credit, management and the risk that a position could not be closed when most advantageous. Investing in derivatives could lose more than the amount invested. Swaps are a type of privately negotiated derivative; there is no central exchange or market for swap transactions and therefore they are less liquid than exchange-traded instruments.

No representation is being made that any account, product, or strategy will or is likely to achieve profits, losses, or results similar to those shown. Hypothetical or simulated performance results have several inherent limitations. Unlike an actual performance record, simulated results do not represent actual

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performance and are generally prepared with the benefit of hindsight. There are frequently sharp differences between simulated performance results and the actual results subsequently achieved by any particular account, product, or strategy. In addition, since trades have not actually been executed, simulated results cannot account for the impact of certain market risks such as lack of liquidity. There are numerous other factors related to the markets in general or the implementation of any specific investment strategy, which cannot be fully accounted for in the preparation of simulated results and all of which can adversely affect actual results.

The correlation of various indices or securities against one another or against inflation is based upon data over a certain time period. These correlations may vary substantially in the future or over different time periods that can result in greater volatility.

The Citigroup 3-Month Treasury Bill Index is an unmanaged index representing monthly return equivalents of yield averages of the last 3 month Treasury Bill issues. The Lehman Brothers Aggregate Bond Index represents securities that are SEC-registered, taxable, and dollar denominated. The index covers the U.S. investment grade fixed rate bond market, with index components for government and corporate securities, mortgage pass-through securities, and asset-backed securities. These major sectors are subdivided into more specific indices that are calculated and reported on a regular basis. The Lehman Brothers Long-Term Government/Credit Bond Index is generally representative of long-term government and investment grade corporate debt securities, or fixed rate, non-convertible, investment grade US dollar denominated bonds having maturities of greater than ten years. The MSCI EAFE (Morgan Stanley Capital International Europe, Australasia, Far East Index) is an unmanaged index of over 900 companies, and is a generally accepted benchmark for major overseas markets. Index weightings represent the relative capitalizations of the major overseas markets included in the index on a U.S. dollar adjusted basis. The Standard & Poor's 500 Stock Price Index is an unmanaged market index generally considered representative of the stock market as a whole. The index focuses on the Large-Cap segment of the U.S. equities market. The Lehman Brothers Par Swap Index is effectively a long position in a fixed-coupon bond plus a short in the floating leg (with principal). At inception and on all quarterly payment dates, the floating leg is worth exactly par because it represents borrowing at the prevailing market rate. The swap is initiated at zero cost, while the bond must be worth par because the value of the fixed leg initially equals that of the floating leg. It is not possible to invest directly in an unmanaged index.

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