Executive summary. This paper explains the key elements to consider when creating an all-bond or nearly all-bond portfolio designed to fully hedge or “immunize” the obligation to make pension payments. These elements include:

- **Curve mismatch.** Exposure to interest rate sensitivity at different points on the yield curve, which is different from the pension liability.

- **Basis mismatch.** Exposure to rates such as Treasury or swap rates, which are different from the corporate bond rates used to measure pension liabilities.

- **Yield.** The net expected yield on a portfolio.

We also compare the use of bond funds to more customized portfolios with smaller numbers of bonds for reasons such as cost, liquidity, and diversification. Although a perfect match with pension payment liabilities is not achievable with any strategy, carefully weighing all of these factors will help plan sponsors reach their desired objectives.
As plan sponsors become more concerned about choosing pension investments to reduce risk rather than boost return, they become more interested in how to match assets with a pension liability. Most early stage liability-driven investment (LDI) strategies concentrate on introducing interest rate sensitivity (duration) to the assets, with a focus on the amount—not the characteristics—of the duration. As these strategies progress, more emphasis is placed on the precise matching of assets to expected pension payments, or “immunization.” In this paper, we address immunization issues and remind those who want maximum risk reduction that a number of important considerations do not always receive the attention that they should. Based on those factors, we compare the vehicles available to implement an immunized approach—in particular, diversified bond funds and customized portfolios of individual bonds.

**Immunization**

The term “immunization” is based on the concept of “immunizing” an investor against risk. It is used to describe a fixed income portfolio designed to provide payments that an investor is obligated to make to another party. In some situations it can also be described as “cash flow matching,” because the cash flows of the portfolio usually must be well-matched to the cash flows the investor must pay out. The value of a well-constructed immunization portfolio will change in the same way as the value of the payment obligation. When accounting rules require that an obligation’s value be marked to market using current interest rates, the approach is even more useful. Immunization strategies are often used by insurance companies, banks, and pension plans because many of their obligations have well-defined cash flow requirements.

In this paper we presume that a plan sponsor has dedicated 100% of its portfolio to the objective of matching the expected pension payments. This situation arises when the investor seeks to lock in a plan’s funded status by making the asset value and the value of the payments move together. The strategy is usually applied to a well-funded, frozen pension plan and becomes increasingly important as the funded status of the plan improves. We refer to the requirement to make pension payments as a “liability” and we refer to the risk reduction mechanism employed as “hedging.”

When designing an immunization portfolio for a pension plan, it is important to understand that the use of corporate bond discount rates to measure liabilities creates an uninvestable target for the strategy. That’s because the risk that gives rise to downgrades and defaults in corporate bonds is not present (or is very different) in the pension liability. This issue is sometimes referred to as a “downgrade headwind” or “credit headwind.”

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1 For an explanation of the “downgrade headwind,” see Vanguard’s research papers *For Better Pension Liability Matching, Consider Adding Treasuries* (Bosse and Inglis, 2012) and *Frozen Pension Plans: Immunization or Termination?* (Inglis and Zahn, 2013).
Measuring success: The key factors

Most pension plans first implement an LDI approach by increasing the duration (interest rate sensitivity) of the assets in the portfolio to get closer to the duration of the pension liability. When the methodology moves beyond this to an immunization strategy, two key aspects of the asset-liability match become important:

**Curve mismatch.** This can be thought of as deficiencies in the hedge due to nonparallel movements in the yield curve (see Figure 1). It also encompasses the impact of convexity mismatch, which results when the timing of future expected payments is not well-aligned.

The more precisely the cash flows of the portfolio are matched with the cash flows of the liability, the less curve mismatch will arise. The amount of the mismatch can be measured beforehand by calculating the key rate durations of both the assets and the liabilities. Aligning these will allow for a fairly precise cash flow match, which will minimize curve mismatch, at least at the inception of the strategy.

It is difficult, if not impossible, to match expected cash flow from a pension plan with a portfolio of 100% corporate bonds. Because of a lack of availability of corporate bonds, pension payments in the 10- to 20-year range tend to be hard to match, as do those due after 30 years. The most straightforward solution to this problem is to introduce Treasury STRIPS with specific maturities to fill in the gaps, but this reduces yield and introduces a mismatch with the corporate bond rates used to measure the pension liability.

**Basis mismatch.** This issue arises when the yield used as a discount rate for the liability is based on an asset different from those in the investment portfolio. For instance, Treasuries or interest rate swaps may be used in a hedging strategy while the liability is measured with corporate bond yields. Because yields on Treasuries, swaps, and corporate bonds (and potentially other assets) do not move perfectly in sync, a mismatch arises.

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**Figure 1. Immunization hedges against any yield curve change**

For a **parallel yield curve shift**, a broad duration match will hedge liability movements.

For a **nonparallel yield curve shift**, immunization (matching duration all along the curve) is required to hedge liability movements.

Source: Vanguard.
This is addressed by using primarily corporate bonds to match a pension liability measured using corporate bond discount rates. However, a mismatch will still exist in a 100% corporate bond portfolio because of downgrades and defaults that occur with these bonds (the credit headwind). If pension liabilities were measured with Treasury yields, basis mismatch (and funded status volatility) could be almost eliminated by investing in Treasury securities. However, this approach would result in a much higher liability. In other words, giving up the potential for excess return (above Treasuries) from corporate bonds would increase the ultimate cost of the plan.

Because of the way pension liabilities are measured, curve and basis mismatch are significant issues, and tracking error\(^2\) between assets and liabilities cannot be eliminated. Depending on the type of plan and the type of discount rate used, the best matching portfolios should achieve annual tracking error in the 3% to 5% range.

**Additional considerations**

Other elements are also relevant in assessing any immunization strategy:

**Diversification.** Owning many bonds rather than few will serve to minimize downgrade and default risk related to specific issues (i.e., idiosyncratic risk).

**Liquidity.** The ability to buy and sell investments easily is valuable because the expected pension payments will change to some degree as time passes—for example, when people retire or die in a pattern different from that assumed by the actuary. Adjustments to the portfolio are also required as curve and basis mismatches arise.

**Yield.** It may sometimes be desirable to accept a less precise asset-liability match if the trade-off is additional yield. For example, any expected pension cash flow can be matched very precisely with a portfolio of Treasury STRIPS, but less precise matches using corporate bonds or longer-duration (and higher-yielding) issues may be considered more effective because of their additional yield.

### Table: Comparison of net expected yield

<table>
<thead>
<tr>
<th></th>
<th>Portfolio 1</th>
<th>Portfolio 2</th>
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</thead>
<tbody>
<tr>
<td>Estimated yield for corporate bonds only (A or better)</td>
<td>4.34%</td>
<td>4.40%</td>
</tr>
<tr>
<td>Adjustment when Treasuries are added to improve tracking</td>
<td>–0.53</td>
<td>–0.35</td>
</tr>
<tr>
<td>Portfolio yield</td>
<td>3.81%</td>
<td>4.05%</td>
</tr>
<tr>
<td>Cost of investment management and advice</td>
<td>–0.20</td>
<td>–0.35</td>
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<tr>
<td>Expected impact of downgrades</td>
<td>–0.41</td>
<td>–0.55</td>
</tr>
<tr>
<td>Net expected yield</td>
<td>3.20%</td>
<td>3.15%</td>
</tr>
<tr>
<td>Estimated accounting discount rate (AA)</td>
<td>4.05%</td>
<td>4.05%</td>
</tr>
</tbody>
</table>

Source: Vanguard.

**More about yield**

Estimating the expected net yield on a portfolio is important but requires careful attention to cost and consideration of potential downgrades and defaults.

The full observed spread on corporate bonds over Treasuries will not necessarily be realized because of downgrades (which may force an issue to be divested) or actual defaults. An estimate of this impact should be included when assessing the yield on any portfolio. As we have previously illustrated, Treasury exposure in an immunization portfolio can mitigate the impact of downgrades and defaults and reduce tracking error for a pension liability.\(^3\) However, this reduction needs to be weighed against the additional yield available from corporate bonds.

**Figure 2** compares two sample fixed income portfolios and shows the basic arithmetic needed to assess their yields. Portfolio 2 uses more corporate bonds, which initially gives it a higher yield, but management costs and downgrades reduce its net expected yield below that of Portfolio 1.

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2 In this paper, tracking error refers to a measure of volatility of the asset return relative to the pension liability return, calculated as a standard deviation. This is the same concept as tracking error for an index benchmark, with the pension liability serving as the benchmark.

3 See Vanguard’s research paper *For Better Pension Liability Matching, Consider Adding Treasuries* (Bosse and Inglis, 2012).
Comparing the net expected yield to the estimated accounting discount rate makes it clear that even if a portfolio could eliminate tracking error it would still fall behind the liability. The addition of Treasury securities to improve tracking and the acknowledgement of costs and downgrades creates a considerable gap between what an immunization portfolio will earn and the “return” on a pension’s liability.

**Funds vs. individual bonds**

Although individual bonds can seemingly be precisely matched to a liability, a combination of funds can be customized to achieve very low curve and basis mismatch at lower cost and with better liquidity and diversification.

**Curve and basis match.** When first created, a portfolio of individual bonds can be closely matched to the liability for expected payments. However, a good pension immunization strategy considers potential changes in expected payments that arise after implementation. As cost, net yield, specific issue (idiosyncratic) risk, and the uncertainty of actual future cash flows (for both assets and liabilities) become factors, the initial match is no longer the only relevant measure. A very good ongoing match can be obtained with the right combination of funds.

**Cost.** Costs are one reason that the return on an immunization portfolio’s assets will usually trail its liability, so the lower they are, the better the result. Funds are often less expensive than a custom portfolio of individual bonds.

**Liquidity.** A portfolio of individual bonds, particularly corporate bonds, may be fairly illiquid. It may be difficult and expensive to adjust as changes in expected cash flows (for either the pension plan or the assets) develop. Large bond funds often allow for the purchase and sale of shares at little or no cost. In some cases, transactions may be subsidized by other fund shareholders. But large funds also experience significant “crossing”—times when some shareholders are buying and others are selling. This netting of buys and sells reduces transaction costs.

**Diversification.** Broad-market bond funds offer a significant diversification advantage by investing in hundreds or thousands of bonds. A customized portfolio of 40 or 50 bonds that looks well-matched to a pension’s payments will no longer work as well if any bonds default or are downgraded, as explained below.

**Cash flow matching with individual bonds**

An immunization strategy is often viewed as a cash flow matching approach. Downgrades and other basis mismatch issues may be regarded as minor because as long as no issuers default, cash will be available to make payments when due. However, expected cash flows will change as actual retirements, deaths, and other events occur, and adjustments to the portfolio will need to be made. Also, because most pension plans will be terminated at some point before making the last payment, changes in bond values will affect their ultimate cost even if none of the issuers defaults.

A customized portfolio of individual bonds is expected to provide cash flow (from coupon payments and maturing issues) that matches the required pension payments. But this does not work perfectly in reality. In practice, the expected cash flows from both assets and the pension plan will change, and adjustments can be costly, especially when they are made by buying and selling individual corporate bonds, which tend to trade with wide bid-ask spreads. When matching a combination of funds, a benefit payment strategy—typically taking mostly from the longest-duration fund—can keep the hedge close as time passes. Moving in and out of funds will generally be easier and less expensive than adjusting a portfolio of individual bonds.
Conclusion

No single metric or concept will identify the most effective immunization approach for a pension liability. A completely accurate assessment of the levels of curve and basis mismatch is not possible. And expected net yield on the portfolio, diversification, and liquidity should all also be considered. A customized combination of bond funds can be an excellent way to incorporate all of these elements into an immunization strategy.

References


Inglis, R. Evan, and Nathan Zahm, 2013. *Frozen Pension Plans: Immunization or Termination?* Valley Forge, Pa.: The Vanguard Group.