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**Publication**
February 2006

## Liability-Driven Investments: An Active Fixed Income Approach

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Upcoming regulatory changes will soon force many European pensions and insurance companies to adopt new investment strategies that are focused on matching liabilities rather than maximizing returns. These regulatory changes include implementation of the New Basel Capital Accord (Basel II) in 2006, implementation of the European Commission's "Solvency II" insurance regulations, the Netherlands' new Financial Assessment Framework (FTK) and changes in international accounting standards (IAS 19).

In this article we will explore ways in which liability-driven investments (LDI) may help pension funds adapt to the changing regulatory landscape. While we focus on pension funds, insurance companies face the same problems and may benefit from similar LDI solutions.

### Defining the Problem in an Asset-Liability Management Context

The new regulations will have a profound impact on the way portfolios are structured: more than ever before, pension managers will be forced to focus on the pension surplus, the assets minus the liabilities of a pension fund. To manage the volatility of the surplus and comply with regulatory changes going forward, pension managers will need to focus on the sensitivity of the liabilities to interest rate shifts and measure asset allocation strategies as a function of the marginal risk/return to the surplus, not just on an asset-only basis.

Broadening the investment framework to include liabilities will require pension managers to consider new factors in portfolio construction but does not dictate a rigid portfolio structure designed to exactly match liability cash flows. In fact, one of the first factors to consider is that actuarial forecasting of liabilities is not a perfect science, which argues for a flexible investment approach that seeks a close match with liabilities while maintaining the ability to actively seek added value in ways that can counterbalance forecast error. Pension plan policies regarding inflation compensation and contributions may also affect the surplus and need to be considered as well.

Pension fund portfolios have traditionally relied heavily on market (beta) risk for return, with a relatively high weighting in equities. However, equities may not be suitable for most pension funds going forward (unless solvency rates are high), because of equities' relatively high volatility and the resulting impact on the surplus. In our view, portfolios should be built around four basic concepts:

1. Interest rate risk should be hedged to the extent possible.
2. Beta risk should be added as a function of the overall risk tolerance of the pension fund.
3. Alpha (the ability to generate excess return versus a given benchmark) should be the main engine of return.

4. Although inflation is not explicitly part of the solvency calculations, it cannot be ignored as it impacts expected future cash flows via wage inflation.

In the following sections, we will discuss each of the four concepts around which we believe an LDI portfolio should be constructed and PIMCO's approach to implementing each concept. We begin with a process for modeling liability cash flows and constructing a benchmark portfolio that hedges interest rate risk, but bear in mind that the benchmark is only a tool in the larger process of creating an effective LDI solution. The next steps—actively managing the pension assets in an effort to enhance returns and offset liability forecasting errors and/or inflation risk—are equally important to the success of an LDI solution.

## LDI Benchmark Modeling at PIMCO

PIMCO employs four steps when constructing an LDI solution. We begin by modeling liability cash flows, after which we construct a benchmark for the portfolio based on the structure of the liabilities. Next, we analyze the benchmark's performance to assess mismatches between the cashflows of the benchmark and the liabilities. In the final step, we attempt to optimize the portfolio to minimize any mismatches.

### Step 1: Cash Flows as a Security

When modeling liabilities, PIMCO begins by treating the stream of cash flows like a security. PIMCO's team of financial engineers uses proprietary risk measures to compute the liability stream's sensitivity to changes in yield curve level, yield curve shape, currency, inflation and spreads. PIMCO also uses a series of models to "stress-test" the liability stream to evaluate its performance in a variety of market scenarios. These risk measures and models are the same tools we use on a day-to-day basis to monitor securities in the firm's existing 1000+ accounts and indices. Thus, the analysis of the cash flows of the liabilities and the cash flows of the securities is consistent with the method we use to construct the LDI benchmark in Step 2.

### Step 2: Building a Benchmark

Given the risk profile of the liability cash flows, the Analytics Group will build a hypothetical portfolio of liquid fixed income securities that aims to meet the cash flow requirements as closely as possible. The extent to which the solution can track the cash flows depends on a variety of factors, the main ones being client specifications on securities to be used. For example, a client that specifies a 20% inflation indexation limit will not be able to hedge inflation as well as a client who is willing to have 50% indexation.

When constructing the benchmark, client guidelines will determine the extent to which we are able to address typical challenges in matching cash flows. For example, ultra-long duration liability profiles present a common problem. A profile with a duration of 20 years or above cannot be duration-hedged even with the longest conventional bond (for example, 50-year French OATs have a duration of about 23 years). In this case some less liquid instruments, like Strips or long Swaps, may help to provide extra duration.

Curve duration, defined as the sensitivity of the portfolio to a 100 bp steepening of the yield curve, with the 10-year as pivot, can also present a challenge. Typically, a portfolio that contains government bonds will have a steepening bias compared to the liability cash flows, due to the longer maturity of the liability. The bias can be removed by paying swaps in the front end and hedging via receiving swaps in longer maturities.

Convexity is another typical source of mismatches between the benchmark and liabilities with ultra-long maturities. Here as well, use of swaps and derivatives can be extremely helpful to track the cash flows very closely. In all these cases, it is clear that client restrictions on the use of swaps/derivatives/structured products can limit the "fit" of the solution to the cash flows.

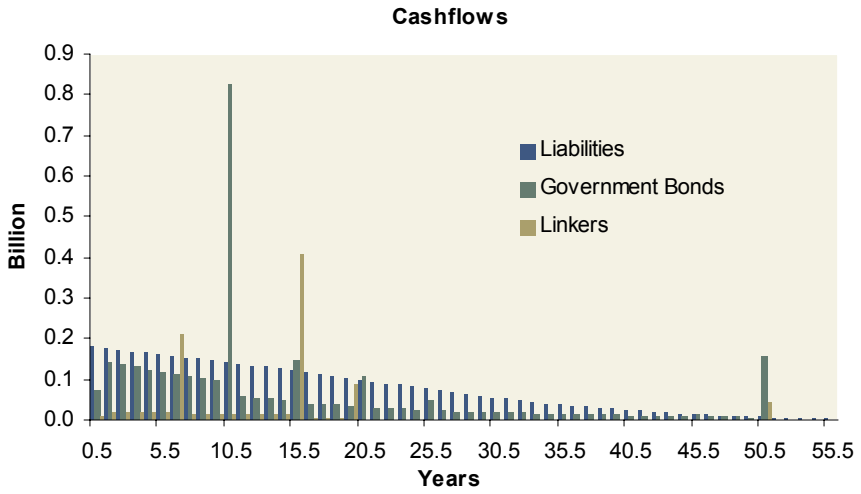
**Step 3: Analyzing the Benchmark's Performance**
Once a benchmark is built, mismatches versus the cash flows are summarized in a table like the following model case:

**Hypothetical examples for illustrative purposes only. The information in the following charts and tables does not represent the past or future performance of any PIMCO product.**

| | Government Bonds | Liability | Difference |
|---|---|---|---|
| Present Value – Base | 100% | 100% | 0 |
| Duration – Base | 17.28 | 17.28 | 0.00 |
| Duration – Bull[1] | 17.91 | 18.08 | (0.17) |
| Duration – Bear[2] | 16.56 | 16.53 | 0.03 |
| 2/10 Duration | (0.21) | (0.01) | (0.20) |
| 10/30 Duration | 16.94 | 16.69 | 0.25 |
| Inflation Duration | 0.00 | 0.00 | 0.00 |
| Convexity | 4.31 | 4.54 | (0.23) |

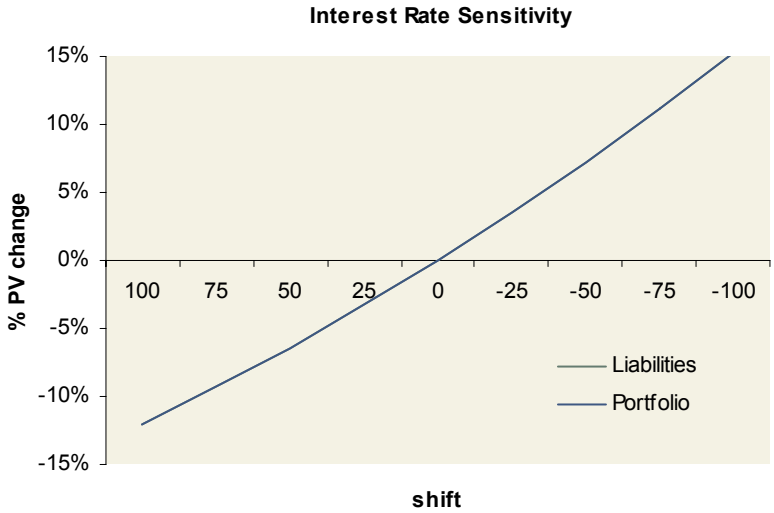
[1]Duration – Bull refers to duration computed after a 50 bps decrease in yield
[2]Duration – Bear refers to duration computed after a 50 bps increase in yield

As the table illustrates, present value and base duration are exactly matched, while the worst mismatches come from 2/10 duration, 10/30 duration and convexity (2/10 and 10/30 durations are defined as price sensitivity to changes in the front-end, and back-end, of the yield curve, respectively). The mismatch in 2/10 duration and 10/30 duration comes from the bullet-type structure of the portfolio: while the liabilities will be smoothly distributed over, say, 50 years, the tracking portfolio will typically consist of not more than six to seven securities spread over the maturity horizon of the liabilities, as shown in the graph below.



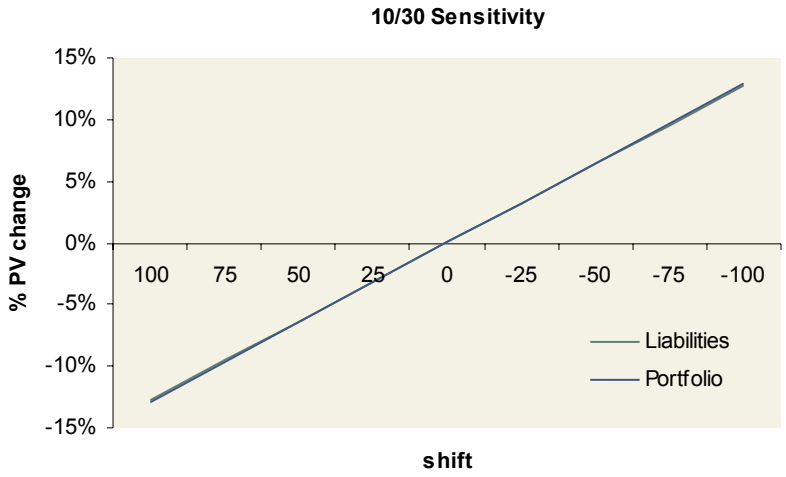

**Source:** PIMCO

Convexity is often the most difficult risk to manage, as most current securities are not convex enough compared to the liabilities (development of a new 50-year maturity sector could provide the instruments to minimize the convexity mismatch). The graph below shows the sensitivity (in percent of present value) of the benchmark and cash flows to parallel shifts in the yield curve. Note how the cash flows and benchmark are indistinguishable because the sensitivity to interest rate risk is identical for liability cash flows ("Liabilities") and the benchmark ("Portfolio").




**Source:** PIMCO. Percentage denotes the net gain/loss in percent due to rate shifts on the underlying cash flows. Shift denotes the positive/negative changes in bp of yields.

The next chart shows the sensitivity of the liability and benchmark cash flows to changes in the 10-year and 30-year portion of the yield curve, illustrating the slight mismatch that develops due to the difference between the 10/30 duration of the benchmark and the liabilities.




**Source:** PIMCO. Percentage denotes the net gain/loss in percent due to rate shifts on the underlying cash flows. Shift denotes the positive/negative changes in bp of 10/30 yield curve spread.

**Step 4: Optimizing the Benchmark**

Once we have analyzed cash flows, constructed a benchmark with a similar profile and identified mismatches between the benchmark and the liability stream, we attempt to optimize the match between the benchmark and liabilities.

Using software created by PIMCO's financial engineers, we can substitute different securities in the benchmark and instantly calculate the effect for each risk measure until we obtain the optimal match between the benchmark and liabilities. The number of securities in the benchmark is directly related to the number of risk measures we are attempting to optimize, which means most LDI benchmarks will not contain more than 10 securities. Obtaining an exact optimization solution may require short positions or custom securities, such as swaps and strips, in which case client guidelines will determine whether an exact match is a workable solution.

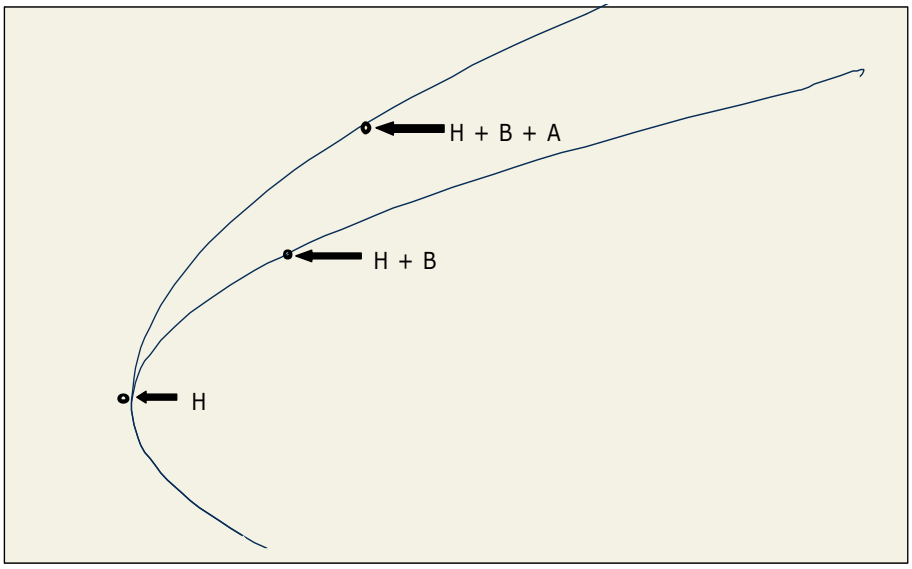
PIMCO's optimization process also enables us to regularly update the benchmark to reflect any changes in the payment stream and preserve the match between the benchmark and the liabilities over time.

## Next Steps: Adding Beta and Alpha to Increase Return Potential

Once we have defined a benchmark portfolio based on the liabilities and hedged the interest rate risk, we can add beta and alpha risk in an attempt to increase the

expected return of the portfolio. Again, this will be a function of the risk budget and the marginal risk/return attribution to the surplus, rather than in an asset-only context. Given the lower volatility of fixed income, bond-based strategies will dominate this portfolio.

Theoretically, the picture is as follows: H= hedge portfolio, B= Beta risk, A = alpha risk




**Source:** PIMCO

Operationally, incorporating alpha and beta can be done in two separate ways:

**Solution 1:** After having established a pure hedging portfolio, a separate portfolio can be created to incorporate all beta and alpha opportunities.

**Solution 2:** Combine a hedging portfolio with an active fixed income portfolio and add beta and alpha risk to diversify the overall portfolio. (See the point H+B+A in the chart above.)

Although Solution 1 may work for sophisticated pension funds, it also requires a significant investment in risk monitoring systems and operational systems. It will require managers to abandon traditional thinking about asset classes and instead focus on a more analytical approach to spend the risk budget of the pension fund according to marginal risk/return to the surplus. It also requires extensive knowledge and compliance monitoring to ensure that derivatives are applied correctly to take in risks that are desired and at the same time making sure that no other unwanted risks creep into the portfolio (e.g. counterparty risk).

Given these practical problems, Solution 2 may prove to be the next best solution and the most practical way to incorporate alpha and beta opportunities. This is achieved by exploiting the full universe of investment possibilities, rather than being restricted by the chosen benchmark (in this case closely mirroring the liabilities). By determining an ex-ante tracking error versus the customized benchmark, the pension fund can rely on an active manager taking calculated risk—by diversifying strategies—in order to outperform the liability-driven benchmark, while avoiding being ”locked in” by the same benchmark.

It is worth highlighting that alpha strategies in long-duration mandates are not inherently “riskier” than in standard mandates (e.g. euro aggregate mandates). An active fixed-income manager should spend the risk budget in a diversified way, by overlaying the benchmark portfolio with an array of fixed-income opportunities.

Alpha found in different areas of the yield curve as well as outside the base currency can be “ported” on the chosen benchmark, potentially enhancing the return of the portfolio. The concept of portable alpha can be explained by a simple observation on yield curve segmentation: whereas the short end of most yield curves is anchored by money market funds looking for investments up to two years, the long end of the yield curve is anchored by institutional investors looking for long-term assets to match liabilities. As a result, the middle part of the curve largely “unanchored”, as there are no natural buyers of this part of the curve, allowing an active fixed income manager to potentially arbitrage segmentation and exploit the steeper roll-down of the curve in the 3-5 year area. This alpha can than be “ported” to the chosen benchmark, regardless of whether the benchmark is long duration or based on LIBOR.

### Inflation and the Impact on LDI

The effect on the solvency rate if inflation were to be unconditionally compensated would be gigantic: using break-even inflation rates derived from inflation-linked bonds to form a real yield curve, the average pension fund would take an additional 25-40% hit in the solvency rate.

Even though in most cases pension funds have switched to conditional inflation compensation and therefore a nominal framework for hedging liabilities is sufficient, we cannot ignore inflation altogether for two reasons. First, liabilities will rise in line with real wage inflation, thus raising the overall liabilities to be covered. Second, most pension funds will at least strive to partially compensate pensioners for inflation and thus will strive for a higher surplus that will allow them to pay out this compensation.

In our view, an inflation compensation “ambition” of the pension fund is a rather vague concept and hard to model. In that respect it might be good to look at the UK model, where many pension plans have an explicit upper limit for inflation compensation (most commonly 5%).

In the absence of such specific rules, inflation-linked bonds can fulfill a role in both the hedging portfolio, as well as play a role in adding beta risk:

- Inflation-linked bonds provide a direct link with consumer inflation, which has a high correlation with wage inflation. Euro- or even global inflation-linked bonds provide the necessary liquidity and desired correlation with domestic inflation to allocate substantial amounts to this asset class.

- Due to diversification effects in the portfolio, inflation-linked bonds can "free up" risk budget to be allocated elsewhere (e.g. alternative asset classes).

## Conclusions

Upcoming regulatory changes will have a significant effect on the way European pension funds and insurance companies manage their assets and liabilities. Instead of return-driven investment strategies, pension funds and insurance companies alike will need to develop a liability-driven investment approach based on managing the volatility of the surplus assets relative to liabilities.

When creating an LDI solution for our clients, PIMCO starts by hedging interest rate risk by modeling the interest rate risk of the liability stream and then creating a custom benchmark with the same risk profile. We actively manage the client's portfolio of assets against the custom LDI benchmark, adding diversified alpha and beta exposure in an effort to enhance returns while maintaining the match between the portfolio's risk profile and that of the benchmark.

* The authors wish to thank the Financial Engineering team and Jim Moore at PIMCO, as well as Steve Goldman, Paul Allen and Mike Amey at PIMCO Europe Ltd for their contributions.

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**Publication**
February 2006

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