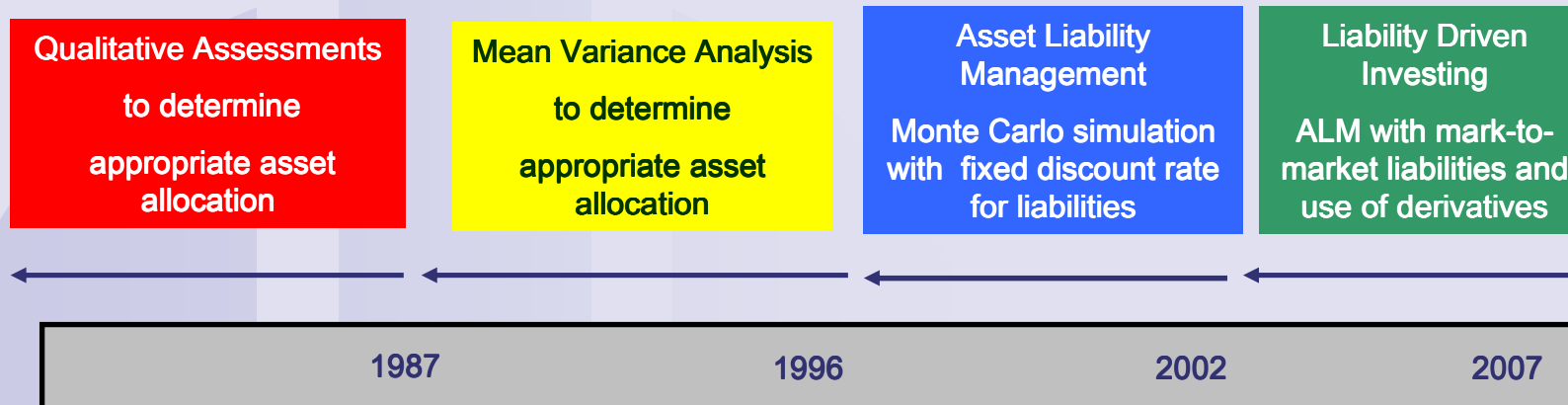


Liability Driven Investment

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Hedge Fund Investments Japan IQ 2007
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Tokyo

Evolution of pension investment thinking



Key investment theme:

How much to invest in stocks versus bonds?

Key investment theme:

International diversification (domestic versus international equities)

Key investment theme:

Diversification into alternative investments (private equity, hedge funds)

Key investment themes:

- Use of derivatives to hedge interest rate exposure in liabilities
- Further diversification into alternative investments (e.g. portable alpha and commodities)

Road Map



- Traditional ALM practice and its implications for pension portfolios
- Liability driven investing and common misconceptions
- Typical risks in pension liabilities and the importance of derivatives
- Considerations in determining the optimal asset allocation

Traditional ALM practice has led to a heavy dose of equities and a significant duration mismatch



- Liabilities are discounted at an actuarial discount rate
- Optimal asset allocations are generated using mean variance optimization
- Monte Carlo simulation is used to generate many future scenarios for asset returns, funded ratios and contribution rates
- Based on these simulated scenarios, risk statistics are calculated, e.g.
 - the probability that the funded ratio will breach certain levels
 - the volatility of contributions and changes in the funded ratio
- A heavy allocation to equities (50% to 80%) – assuming a large enough equity risk premium – seems optimal over the long-term based on the Monte Carlo simulation model
- Some allocation to fixed income (20% to 40%) seems optimal
 - typically benchmarked against an intermediate duration fixed income benchmark (roughly 5-year duration)

Equities have been the asset class of choice for many pension funds

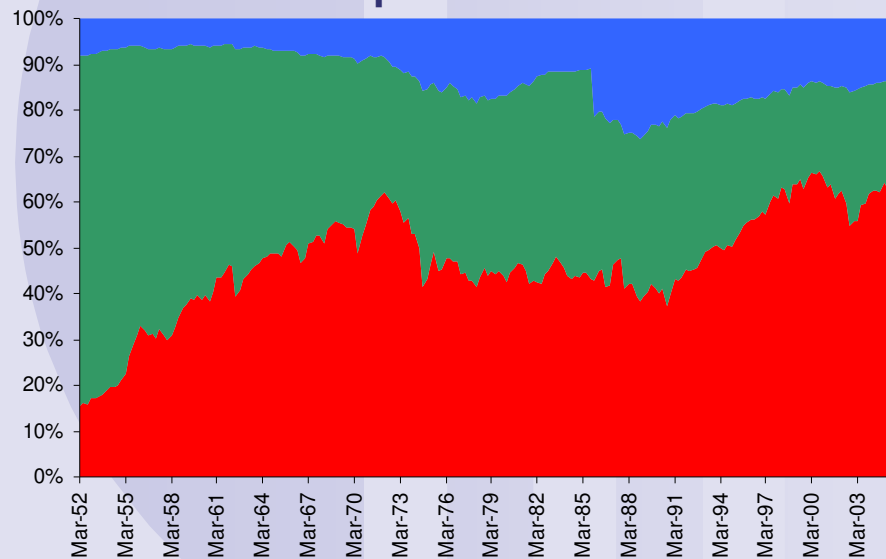


Asset allocations of defined benefit plans in the US went from 0%-15% in equities in 1952 to about 65-70% in 2005!

- Other
- Fixed Income
- Equities

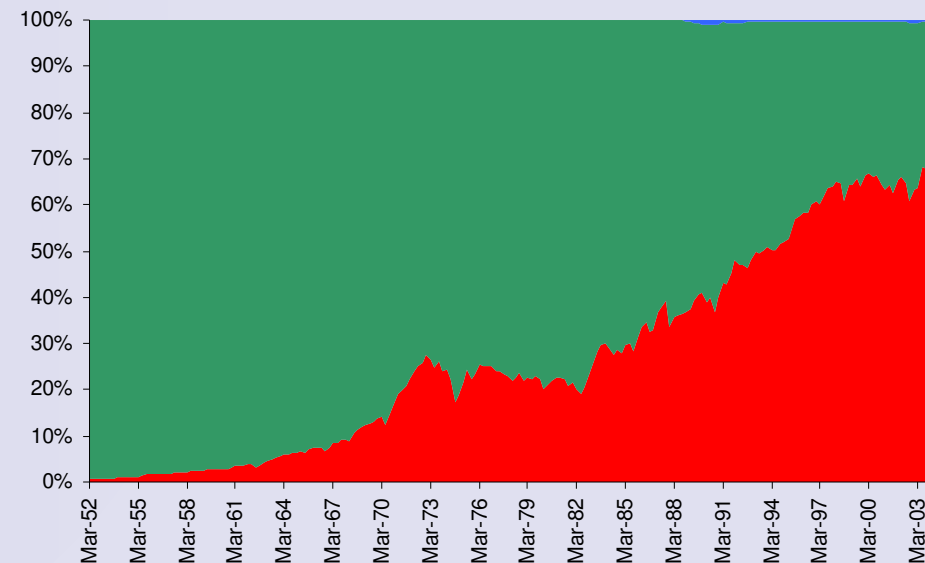
Asset Allocation

US Corporate Pension Plans



Asset Allocation

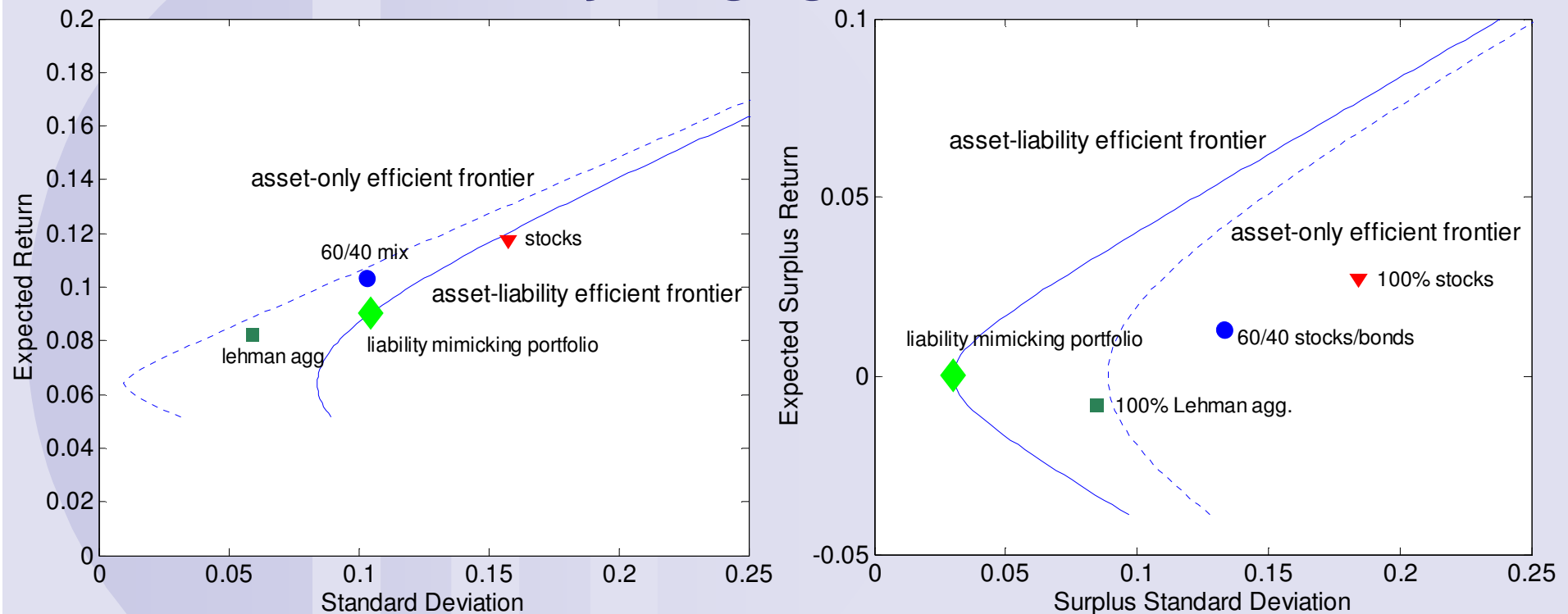
US Public Pension Plans



The typical pension portfolio is not liability-driven but asset-only driven



The typical pension portfolio is grossly inefficient in asset-liability space. Asset-only optimization ignores the so-called liability hedging credits...



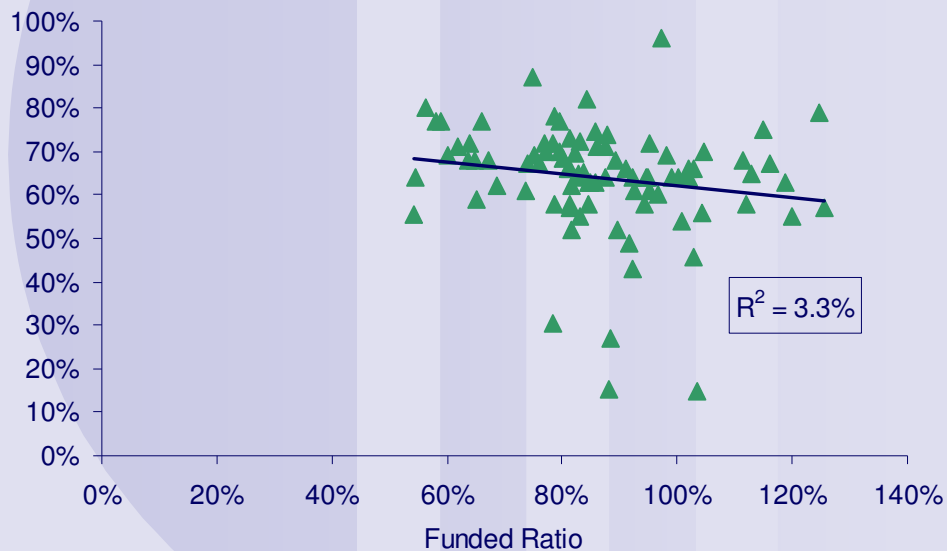
Based on historical returns from 1972 to 2005; optimal surplus portfolios based on Sharpe & Tint (1990).

Asset allocation is driven by herding behavior... not by liabilities...

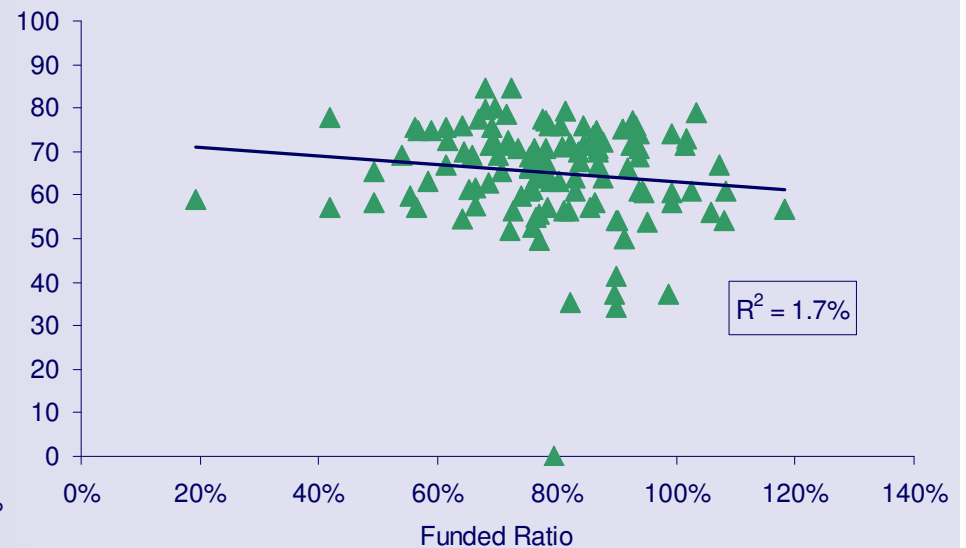


Asset allocations of defined benefit plans in the US are unrelated to the funded status of the plan

Equity & Alternatives Allocation versus Plan Funded Status:
100 largest US Corporate Plans



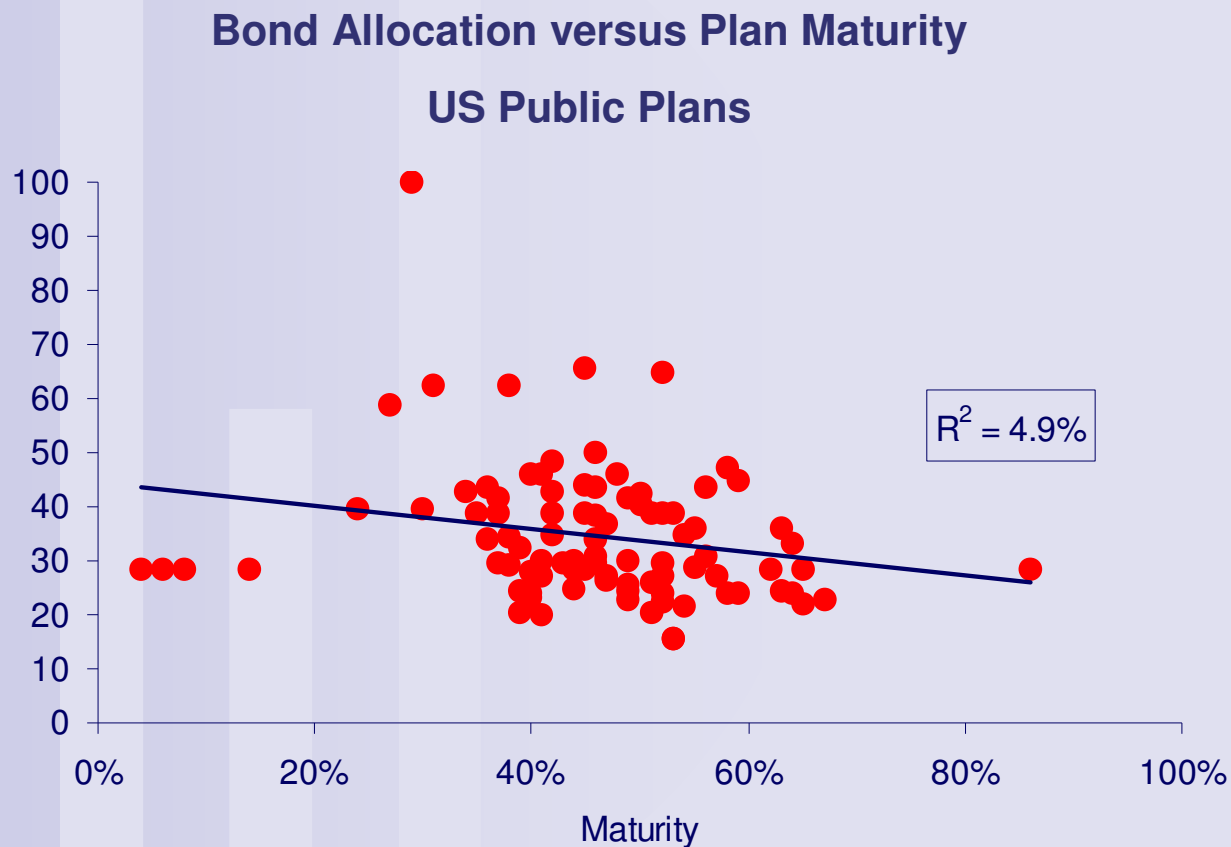
Equity & Alternatives Allocation versus Plan Funded Status:
US Public Plans



Asset allocation is driven by herding behavior... not by liabilities... (cont.)



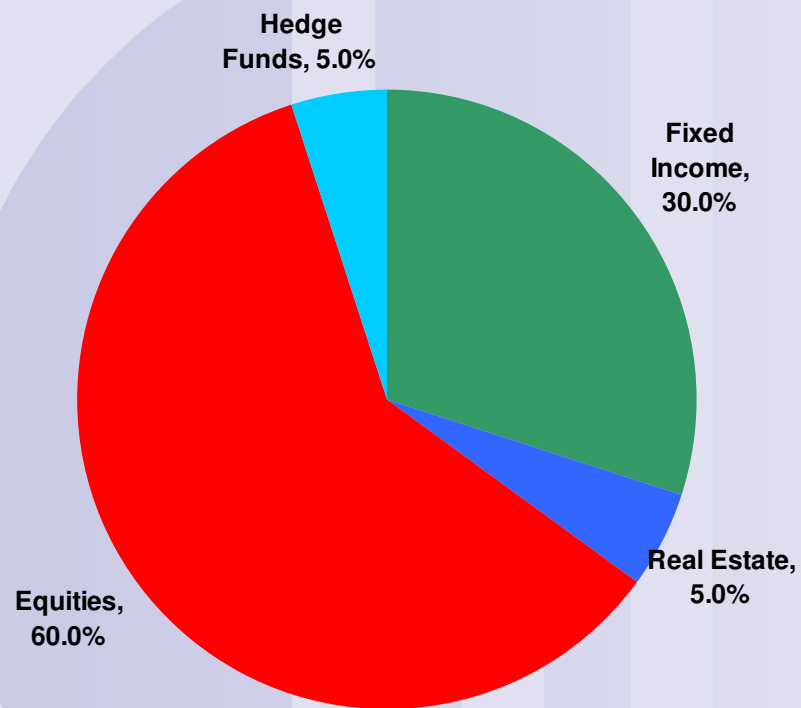
Asset allocations of defined benefit plans in the US are unrelated to the maturity of the plan



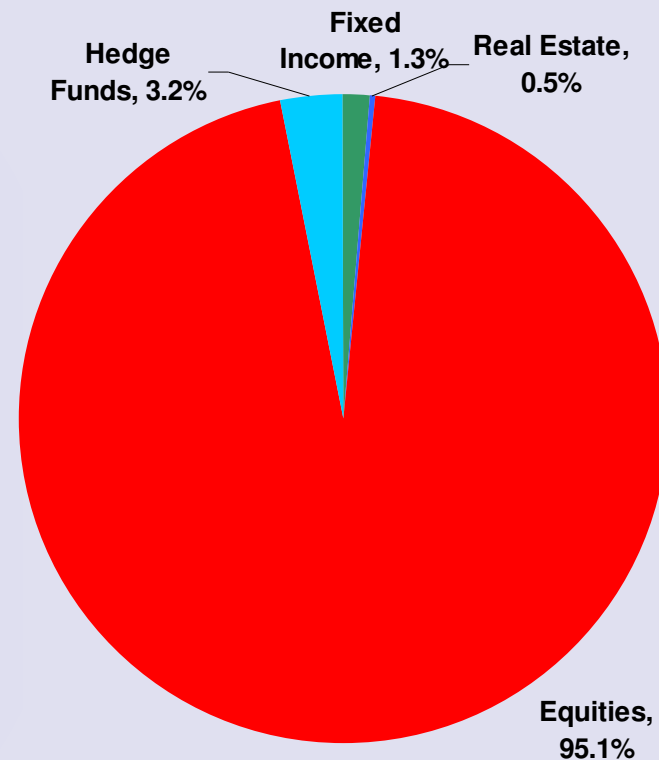
Typical pension risk profile is highly skewed towards equity risk



Typical Strategic Asset Allocation



Portfolio Risk



Standard deviation of typical SAA is about 10.2%

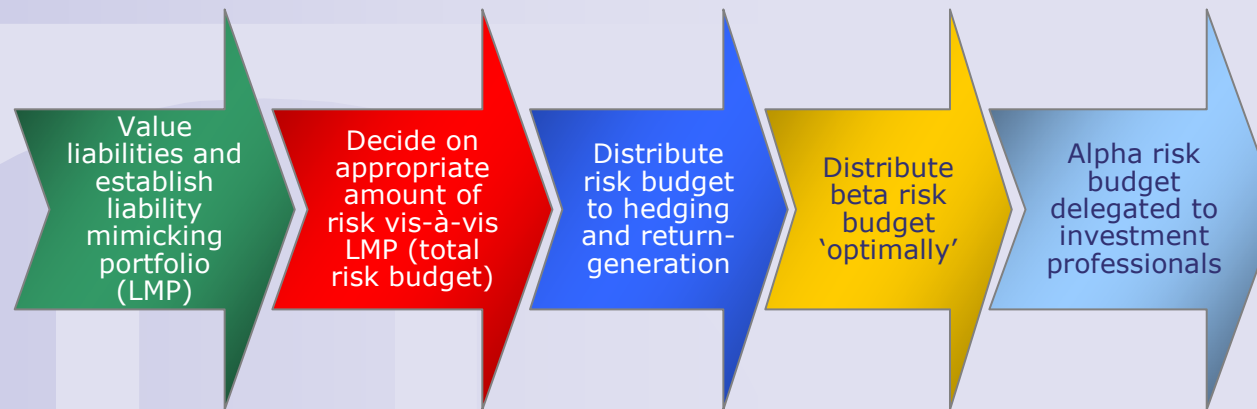
In recent years there has been an increased focus on managing assets against liabilities



Main reasons:

1. The perfect pension storm of 2000-2002 exposed the typical mismatch in many pension portfolios
2. Regulatory & accounting changes require pension funds to mark to market their pension liabilities
3. There is a better understanding in the pension industry of the risks inherent in a DB pension scheme and a better appreciation of the role derivatives markets can play in managing those risks

LDI: decision making process



1. Understand and value liabilities and establish liability mimicking portfolio (LMP)
2. Decide on appropriate amount of risk vis-à-vis LMP (risk budget)
3. Distribute risk optimally between hedging and return generation

Optimal LDI portfolios: three fund separation

- cash
 - liability adjustment portfolio ('swap' on liability mimicking portfolio)
 - optimal overlay portfolio (combination of alpha and beta sources)
4. Beta risk taken by Committee, alpha risk delegated to investment professionals

Misconceptions about LDI



Typical misconceptions include the following:

- LDI is an investment product offered by smart marketers
- LDI is about risk reduction and matching
- LDI forces undue obsession with short-term risks and results in sub-optimal long-term outcomes
- LDI combines hedging with alpha generation

We view LDI as an extension of ALM but using a market-consistent valuation of liabilities and allowing the use of derivatives to create a more optimal risk profile, but...

beware the smart marketers that oversimplify your liabilities and want to sell you overpriced products

LDI is not about reducing overall plan level volatility (or the volatility of the funded ratio), but to more effectively deploy risk in better return-generating assets.

Main risks in pension liabilities

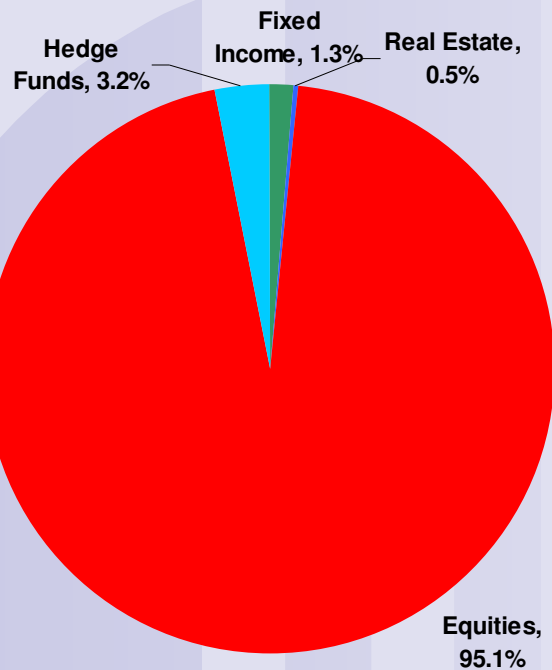


- Interest rate risk (real interest rate risk and inflation risk)
 - pension liabilities typically have long durations: about 15 to 20 years
 - pension assets typically have short durations: about 1 to 4 years
- Labor income risk
 - Real wage growth risk
 - aggregate real wage growth (i.e. net of inflation)
 - individual career path
 - Turnover rates & early retirement
- Demographic risk
 - Individual risks : can be diversified by pooling (insurance)
 - Improving life expectancy
 - Mortality risk: actual experience deviating from projections
- Other risks include: currency risk, credit risk, option-like features

Asset-only v. asset-liability risk

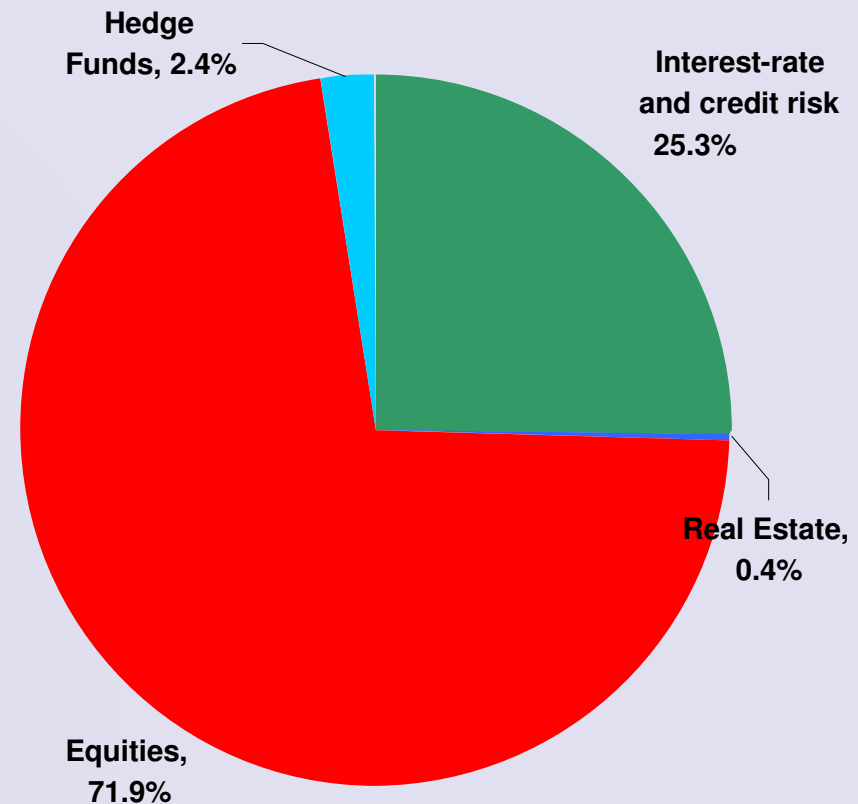


Portfolio Risk



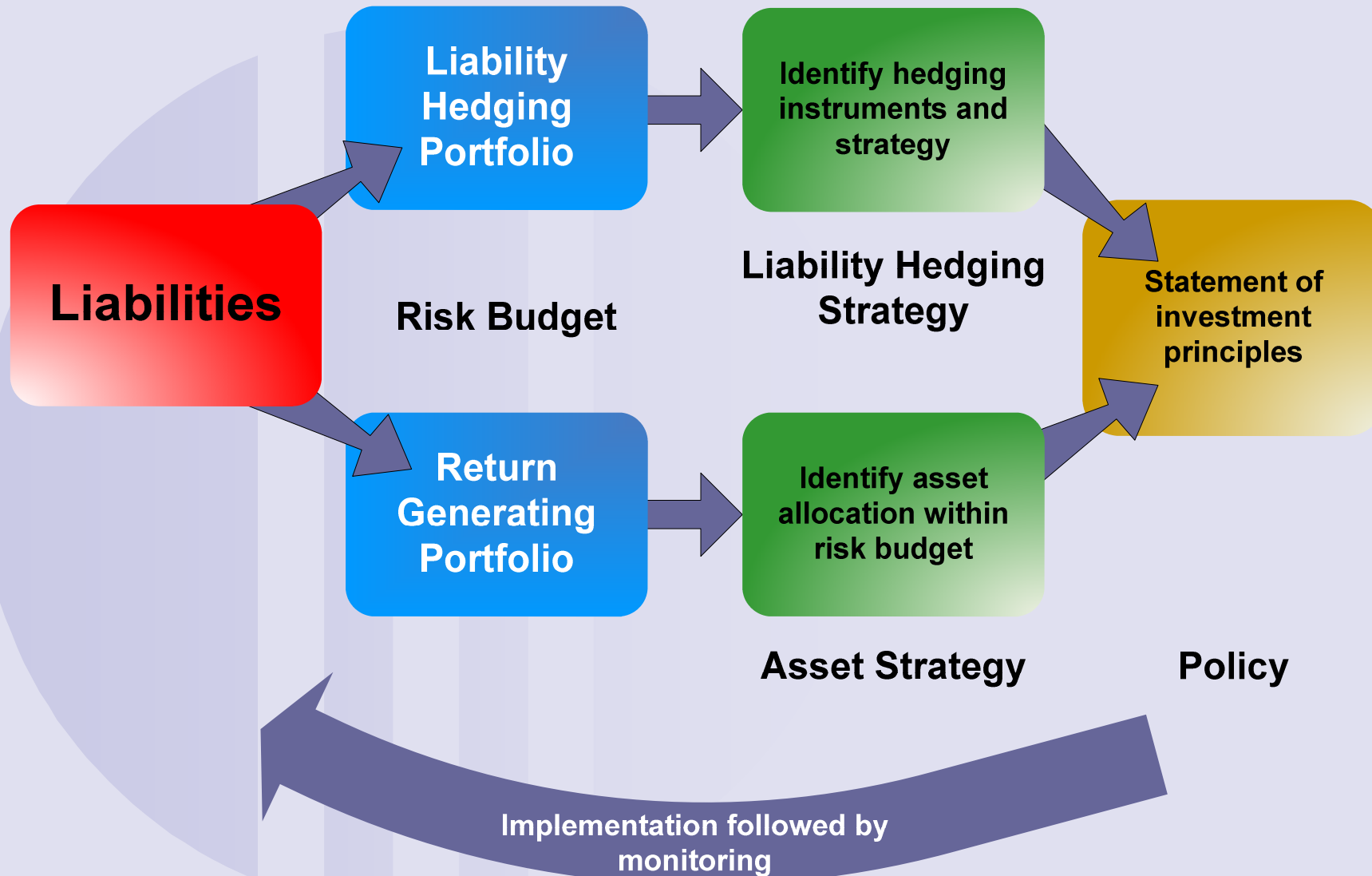
Standard Deviation : 10.2%

Portfolio Risk Relative to Liabilities



Surplus Standard Deviation : 12.7%

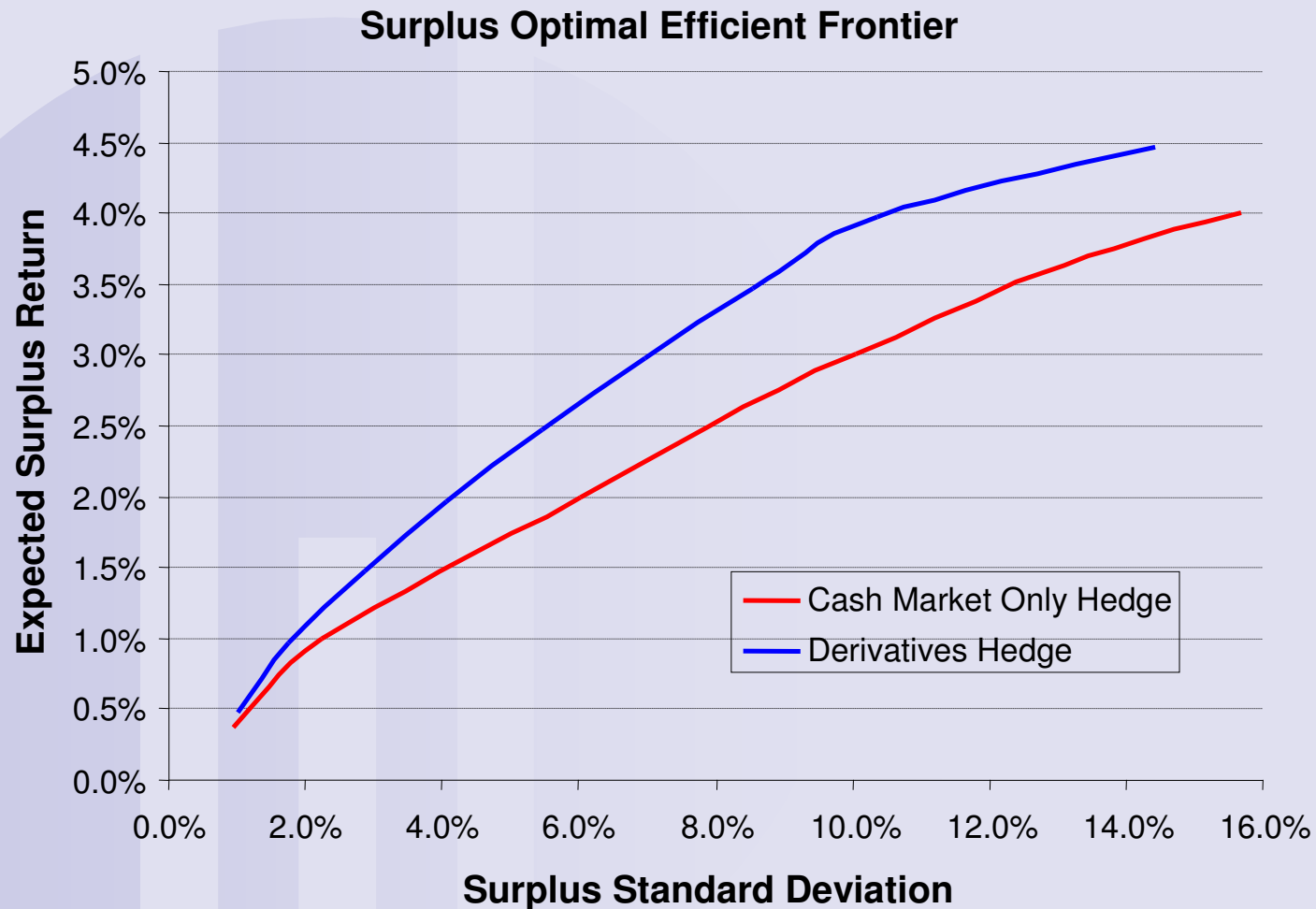
Liability driven investment process



Using swaps to hedge interest rate risk

- LDI involves two objectives: hedge unrewarded risks and take rewarded risks
- Hedging interest rate risk can either be done through the cash market or through the use of the derivatives market
- If hedge is executed through the cash market an investor has to make a trade-off between hedging and return-generating
- If hedging is executed through swap market, both objectives can be achieved but one needs to manage cash collateral and settlements

The efficiency of using derivatives



Risk estimates based on quarterly data from March 1990 to December 2006. Expected returns are forward-looking based on proprietary model.

Constructing a return generating portfolio

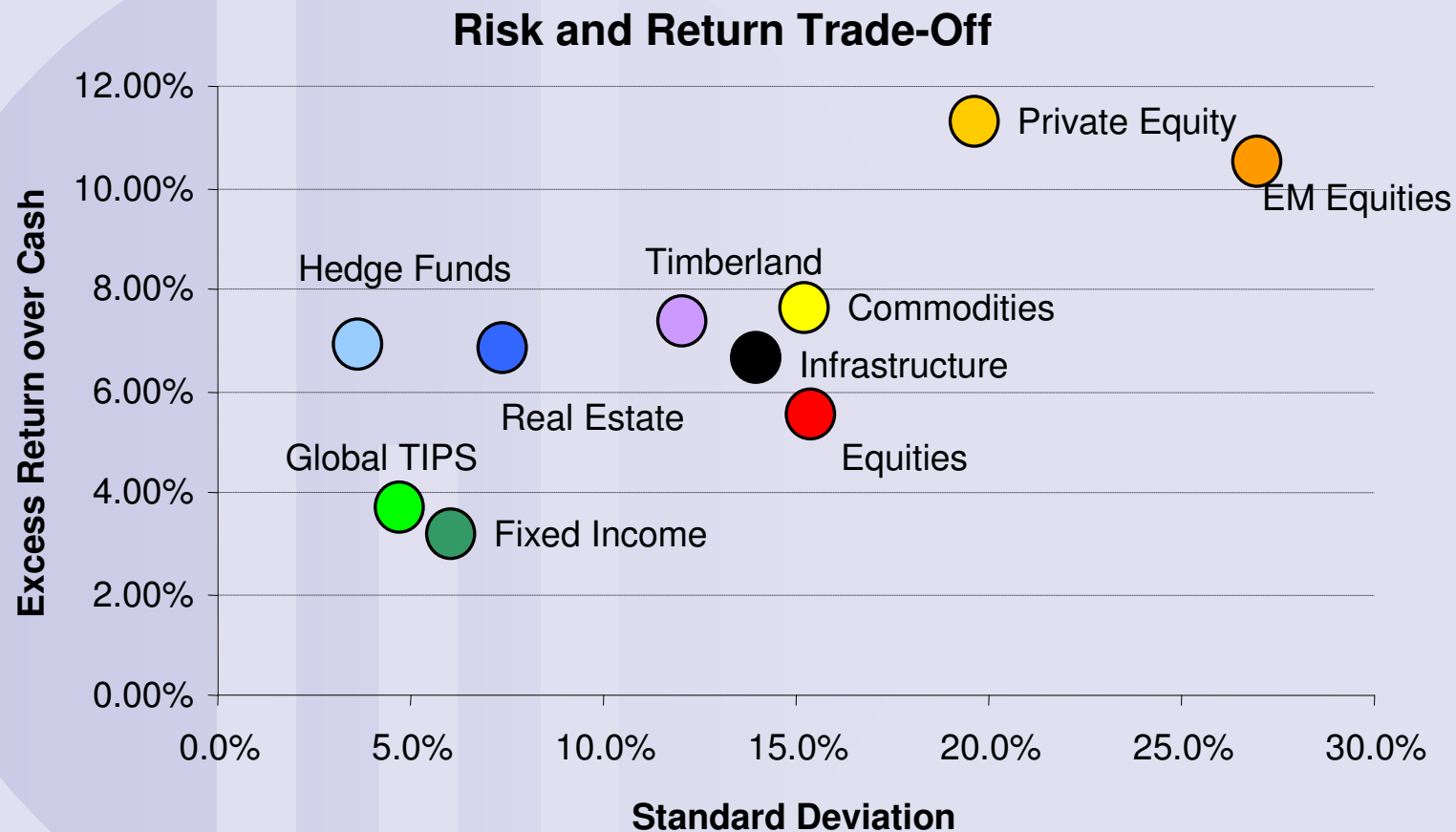


- Hedging the interest rate risk in liabilities using swaps, effectively transforms the liabilities to a LIBOR benchmark
- The return generating portfolio should beat LIBOR over a reasonable period of time and effectively is an asset-only optimal portfolio
- Unhedgeable risks – such as longevity risk – provide a rationale for seeking excess returns over liabilities
- The optimal return generating portfolio can be determined using standard portfolio optimization tools
- This portfolio should extract returns from a diversified combination of both alpha and beta sources

Historical risk return characteristics of different asset classes



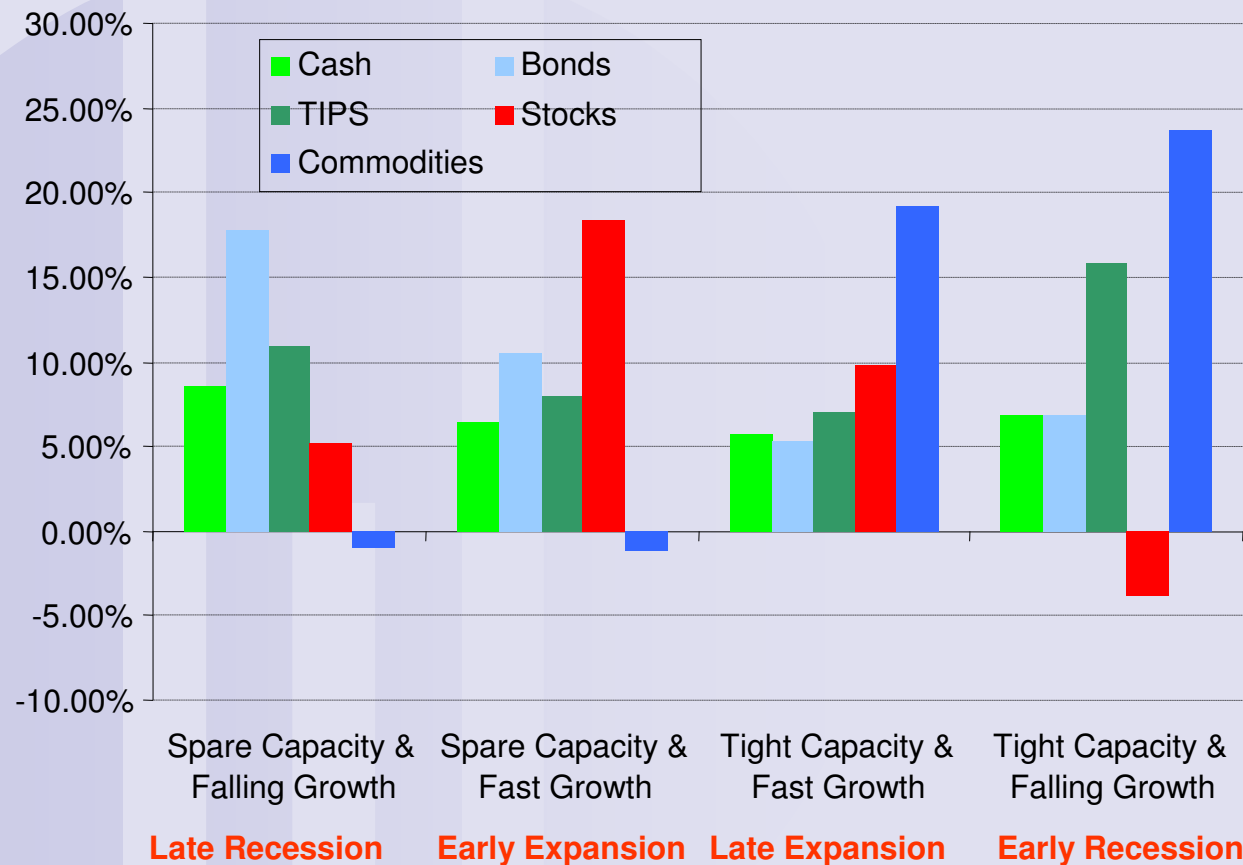
The objective is to construct a well-diversified portfolio



Historical returns based on quarterly data from 1990 to 2006

Different assets produce different returns in each stage of the business cycle

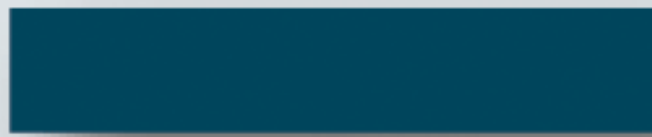
The portfolio should be diversified over the business cycle



Conclusions



- LDI is a decision making framework, not a product.
- A successful implementation of LDI requires the use of derivatives.
- LDI enforces the discipline to make conscious decisions on taking risk in those areas where the investor can expect to be compensated.
- The return generating portfolio should represent a diversified mix of both alpha and beta sources.
- LDI will not prevent another pension storm, but should produce superior risk adjusted returns (relative to liabilities).



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