

## The Theory of LDI

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## Agenda

- What is LDI and why has it developed?
- How does a swap overlay work?
- Practical LDI implementation issues
- Technical considerations in hedge design
- Conclusions

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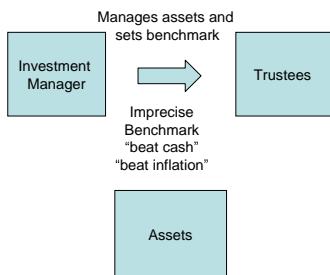
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## Pension fund investment in the 1970s



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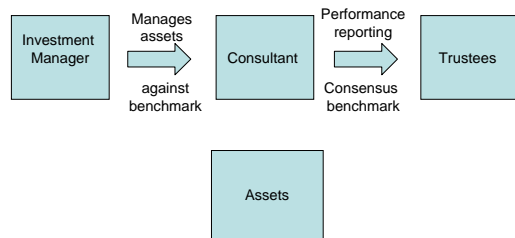
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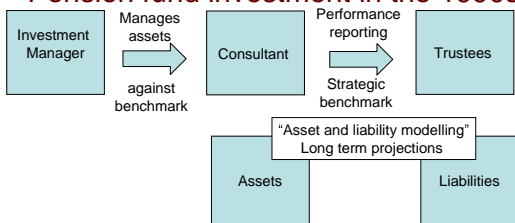
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## Pension fund investment in the 1980s



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## Pension fund investment in the 1990s



■ Prior to mid 1990s actuarial calculations were done in a world of "long term" values that could not be compared directly with "short term" market returns

■ A "twenty year projection" needed to uncover "long term" strategic risk under smoothed actuarial basis

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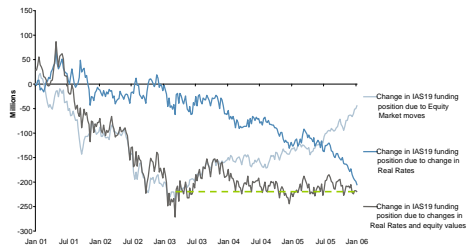
## Why the traditional method failed



- Risk is dominated by risk of asset benchmark relative to liabilities
- Clients thought that "long term" asset and liability models had addressed this
- The simple equation  $\text{total risk}^2 = \text{strategic risk}^2 + \text{tracking error}^2$  was simply not recognised prior to the development of market related valuation

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## Recent impact of “strategic risk”



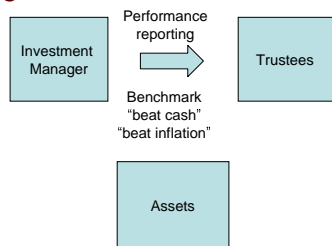
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## Where does LDI fit in ?

- Two different strands of LDI have developed
  - Manager taking on the “long term” role (“unconstrained mandates”)
  - Manager taking responsibility for risk relative to liabilities on market basis
- These represent the two extremes of the spectrum
- In practice LDI is a broad church and most solutions sit somewhere between the two

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## “Long term” mandates

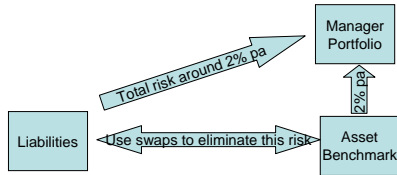


- Appears to have been original *intention* of Myners 2001 Review
- Does not address mark to market risks

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## LDI addressing liability mark to market

- "Mark to market" LDI is not "short term"
- Starting point for mark to market LDI is a projection of liability cashflows
- This may be applied to the full liabilities or just a proportion
  - For example LDI bond mandate



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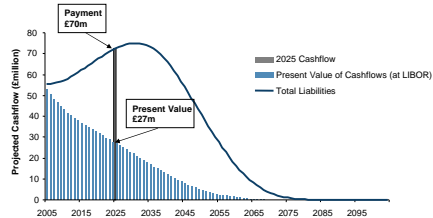
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## Liability matching derivative instruments – interest rate swaps

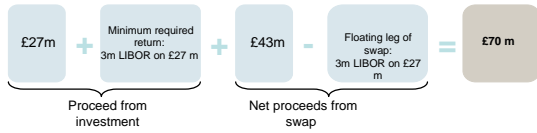
- Interest rate swaps allow a scheme to lock in to the current levels of long term interest rates and remove sensitivity of the funding level to changes in interest rates (as reflected in swap rates) going forward



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## The mechanics of interest rate swaps

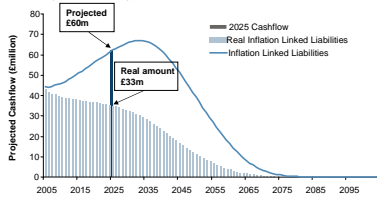
- As long as the scheme's assets deliver returns over 20 years equal to or exceeding the 3 month LIBOR on the £27 million present value, the scheme can pay £70 million in year 20.



The Actuary's Pension  
Modeling the future of the scheme

## Liability matching derivative instruments - inflation swaps

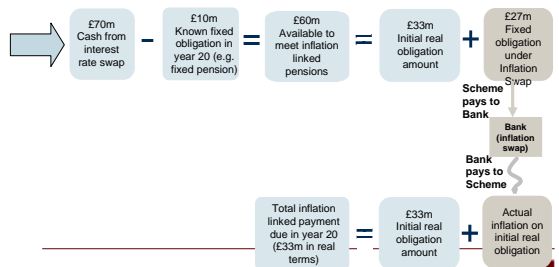
- Inflation swaps allow the Scheme to remove exposure to inflation risk by locking in to the "breakeven inflation" rate offered by the swap market.
- We can illustrate this by considering the projected inflation linked payment in year 20 (say)



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## Mechanics of inflation swaps

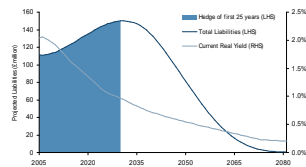
- Inflation swaps can be written in standard "RPI", "LPI(0,5)" or other LPI forms.



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Modeling the future of the scheme

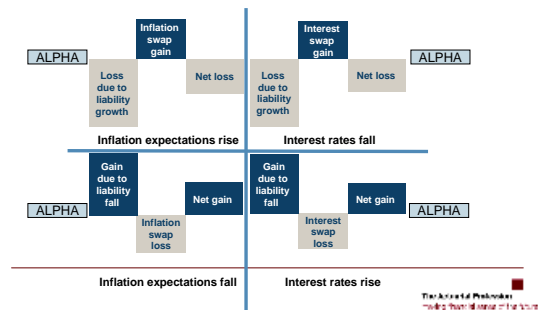
## Typical interest rate and inflation swap LDI mandate

- An LDI mandate might match the profile of the liability cash flows over an appropriate term using interest rate and inflation swaps
- The LDI manager would be measured on the performance of the assets (including swaps) against the value of the liability tranche subject to LDI



The Acton Fund Performance  
Holding Trust of 2005 to 2010

## Impact of swaps (LDI benchmark applied to part of liabilities only)



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Holding Trust of 2005 to 2010

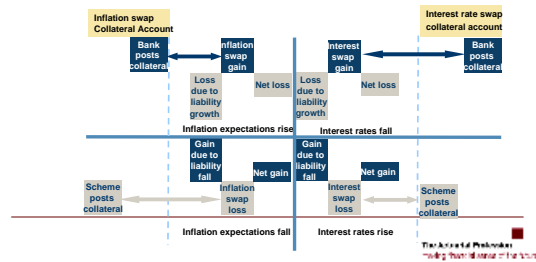
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Holding Trust of 2005 to 2010

## Collateral

- A swap overlay can acquire substantial value to either the scheme or the bank, depending on how interest rates and inflation expectations move.
- If a swap acquires value as an *asset* to one party then this introduces counterparty (default) risk



## Legal construction of collateral exchange

- Collateral will typically consist of either cash or bonds (subject to a "valuation percentage" to allow for market movements in the case of bonds)
  - Gilts (valuation percentage say 99% to 95% depending on term))
  - Supranational debt (98% to 94%)
  - AAA corporate bonds (95% to 90%)
  - AAA commercial paper (95%)
  - Others (as agreed)
- Under English Law CSA *legal ownership* is transferred under collateral exchange, but *beneficial ownership* is not transferred. This means that if bonds are transferred:
  - Bond coupons are paid back to the party that transferred collateral
  - If the bonds fall in value then the party transferring collateral has to top up the account (i.e. the party transferring collateral continues to be exposed to market movements in the asset).
- Cash deposits earn an agreed published interest rate (usually overnight Sterling deposit rate) which is again paid across to the party that transferred the collateral (or credited to collateral account)

The Actual Problem: Holding Both Sides of the Swap

## Practical constraints on LDI solution – available collateral



The Actual Problem: Holding Both Sides of the Swap

## Methods of LDI implementation

- Segregated overlay
  - Existing investment policy left largely unchanged
  - Possible minor changes to accommodate collateral posting requirements (rebalancing funds if large amounts of collateral are posted under extreme rises in interest rates or falls in inflation)
  - If partial hedge only, rebalancing required only if liabilities have fallen by greater amount
- LIBOR based Pooled funds
  - Requires physical allocation of assets into LIBOR (cash deposit) funds from the outset
  - Significant change in investment arrangements in return for elimination of any additional collateral requirements, reduction in legal documentation requirements etc
- Geared funds
  - A compromise between pure overlay and pooled solution, say £100m allocation to fund hedging £300m of liabilities
  - Less reallocation of fund required and simpler implementation
  - Still involves large allocation to underlying "cash" asset
  - Limited availability at present
- LDI plus credit exposure
  - As for LIBOR based pooled funds but underlying asset includes credit exposure

The Acton Fund  
Hedging the Acton Fund

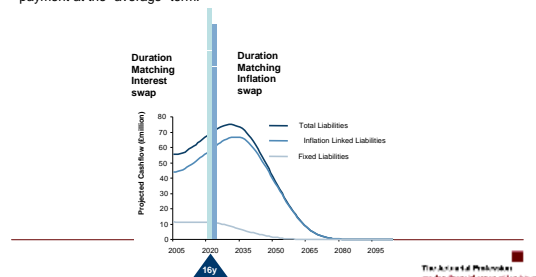
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The Acton Fund  
Hedging the Acton Fund

## Use of swaps in theory

- In theory swaps could simply match the sensitivity of the liabilities to (say) 1% pa changes in interest rates and inflation expectations. This is duration matching.
- The process of duration matching involves treating the liabilities as a single payment at the "average" term.



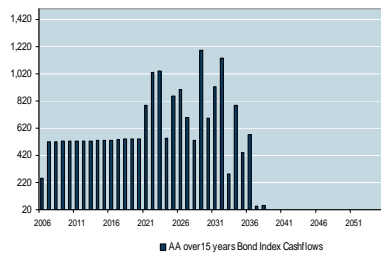


## Practical solution design

- In practice a theoretical approach based only on "duration" has practical problems
  - It is unstable, and it can fail under scenarios where longer term interest rates move differently from shorter term rates (e.g. inversion/dis-inversion of yield curve)
  - Swaps deliver very large cash flows at a single point in time,
  - Implementation involves focussing on a particular maturity point of the market, which may skew the market at the point of execution
  - Convexity matching doesn't necessarily help – convexity is concerned with second order effects associated with parallel moves, not necessarily non parallel moves.
- A superior practical solution is to match "key rate" exposures
  - Stability to large changes in the interest rate and inflation environment
  - Stability to non parallel moves in discount rates (inversion/dis inversion)
  - Cash flows likely to be delivered when needed to meet payment obligations
  - Implementation is spread across all maturities
- The "key rate" exposure of IAS19/FRS17 is of particular interest

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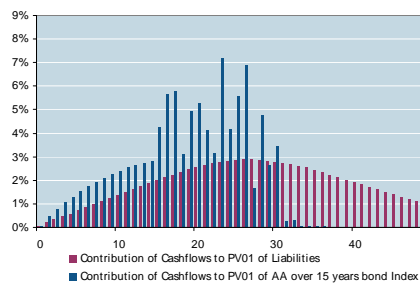
## Typical IAS19 yield benchmark index



- No significant index exposure to rates beyond 30 years
- Primary exposure in the 15-25 year range..

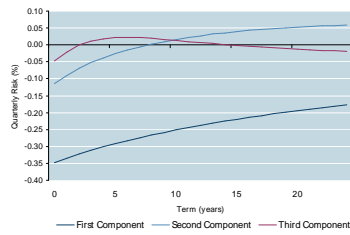
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## Difference in exposure to key rate risk



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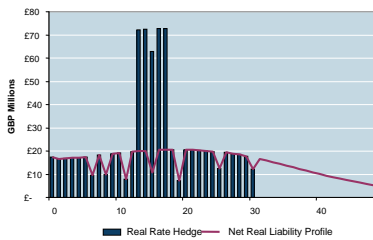
## Principal components of real rate risk



- Over the past decade, 20% of rate risk has related to the second component (inversion/dis inversion)
- A hedge of the economic exposure may behave differently from a hedge of the IAS19 exposure – even if liability duration is the same (and matched)

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Modeling the Real Rate of Return

## A theoretical IAS19 hedge



- A compromise between full economic and IAS19 hedge

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Modeling the Real Rate of Return

## Conclusions

- LDI grew out of the weaknesses of the traditional division between:
  - "Long term" strategic risk measured in non market values
  - Manager risk, the main focus of risk management but not most significant risk
- LDI is a broad church ranging from unconstrained mandates to full hedging
  - In practice most LDI solutions involve a partial hedge of liabilities
- Use of swaps is a key component of "mark to market" LDI
- Swaps can now be implemented on a segregated or pooled basis
- Solution design requires careful consideration
  - Key rate exposure
  - Liability measure being used (IAS19/"economic")

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