

Liability driven investment

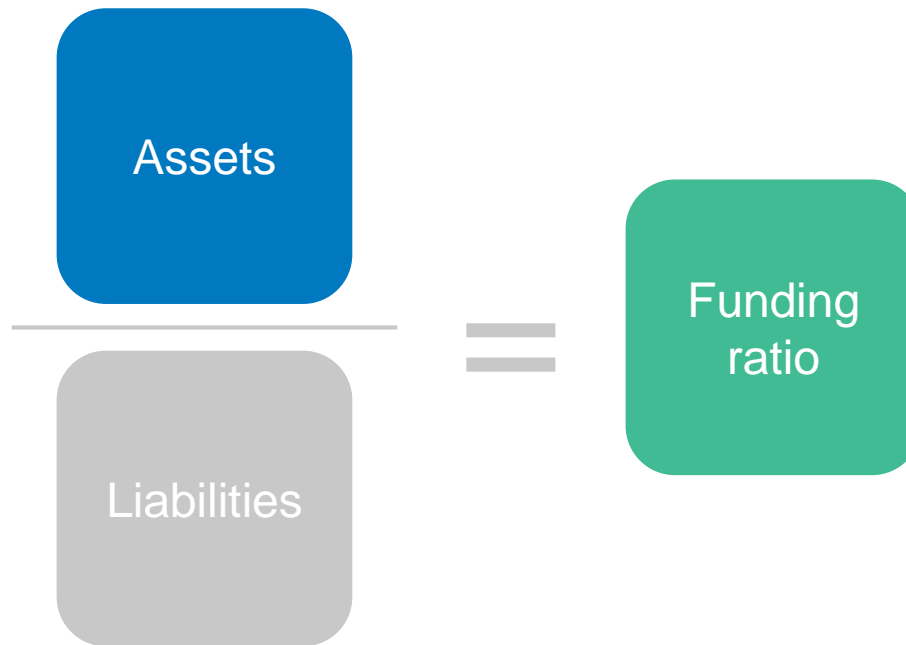
IAPF Trustee Meeting

Contents / Agenda

- An introduction to LDI
- Putting theory into practice
- Considerations for the Irish market

Introduction to liability driven investment

What is LDI?

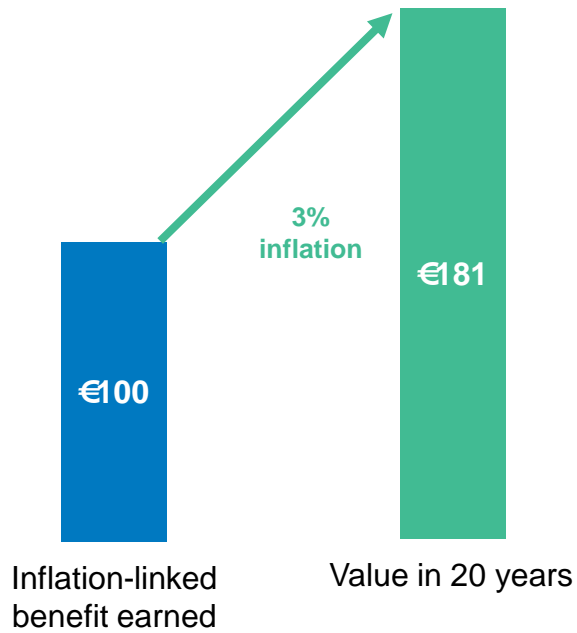


To stabilise the funding ratio, we need to put the liabilities at the heart of your investment strategy

What affects the value of a scheme's liabilities?

The impact of changing inflation

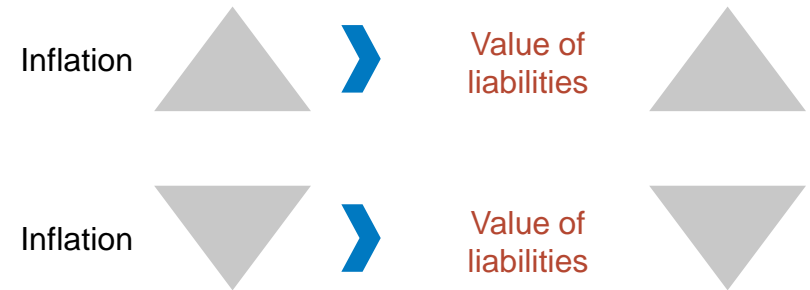
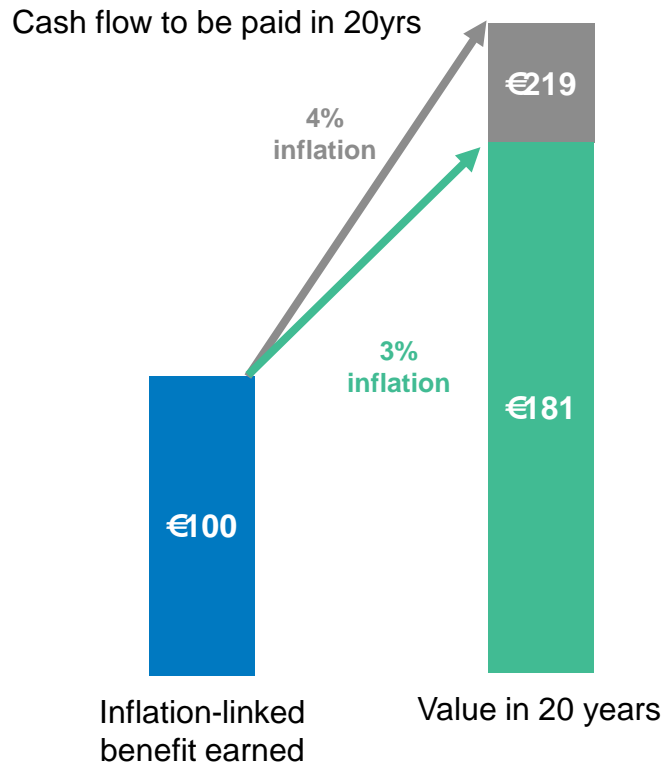
Cash flow to be paid in 20yrs



Source: BMO Global Asset Management. For illustrative purposes only

What affects the value of a scheme's liabilities?

The impact of changing inflation

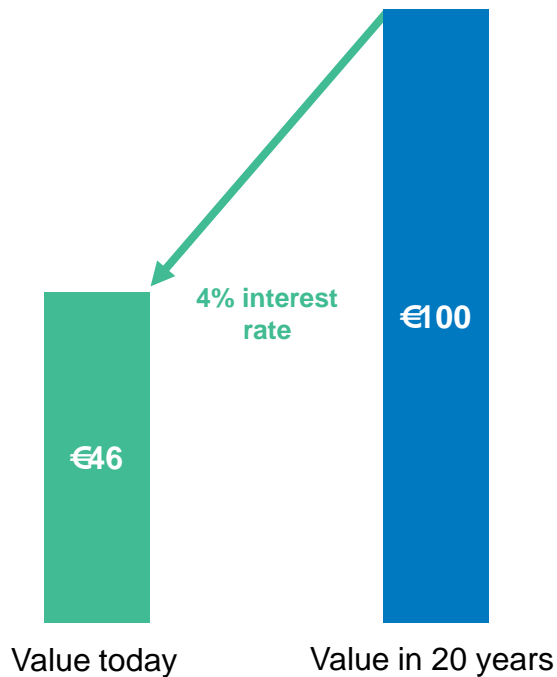


Source: BMO Global Asset Management. For illustrative purposes only

What affects the value of a scheme's liabilities?

The impact of changing interest rates

Cash flow to be paid in 20yrs

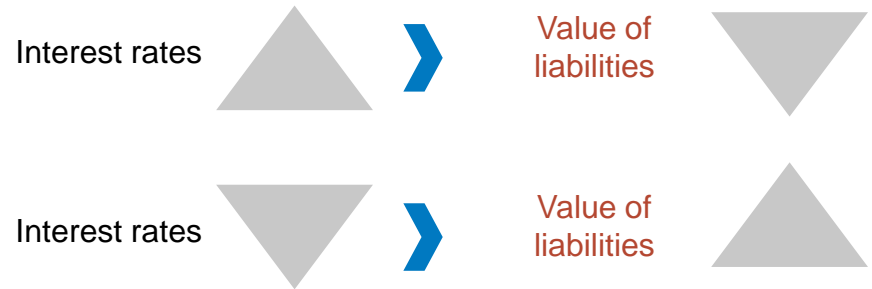
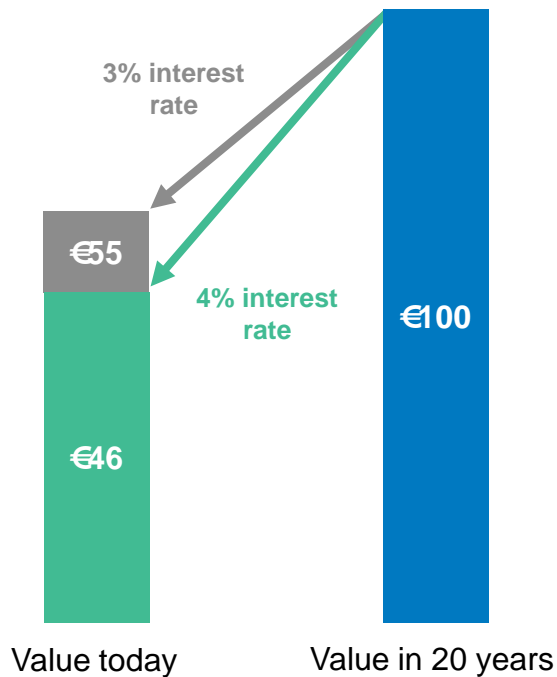


Source: BMO Global Asset Management. For illustrative purposes only

What affects the value of a scheme's liabilities?

The impact of changing interest rates

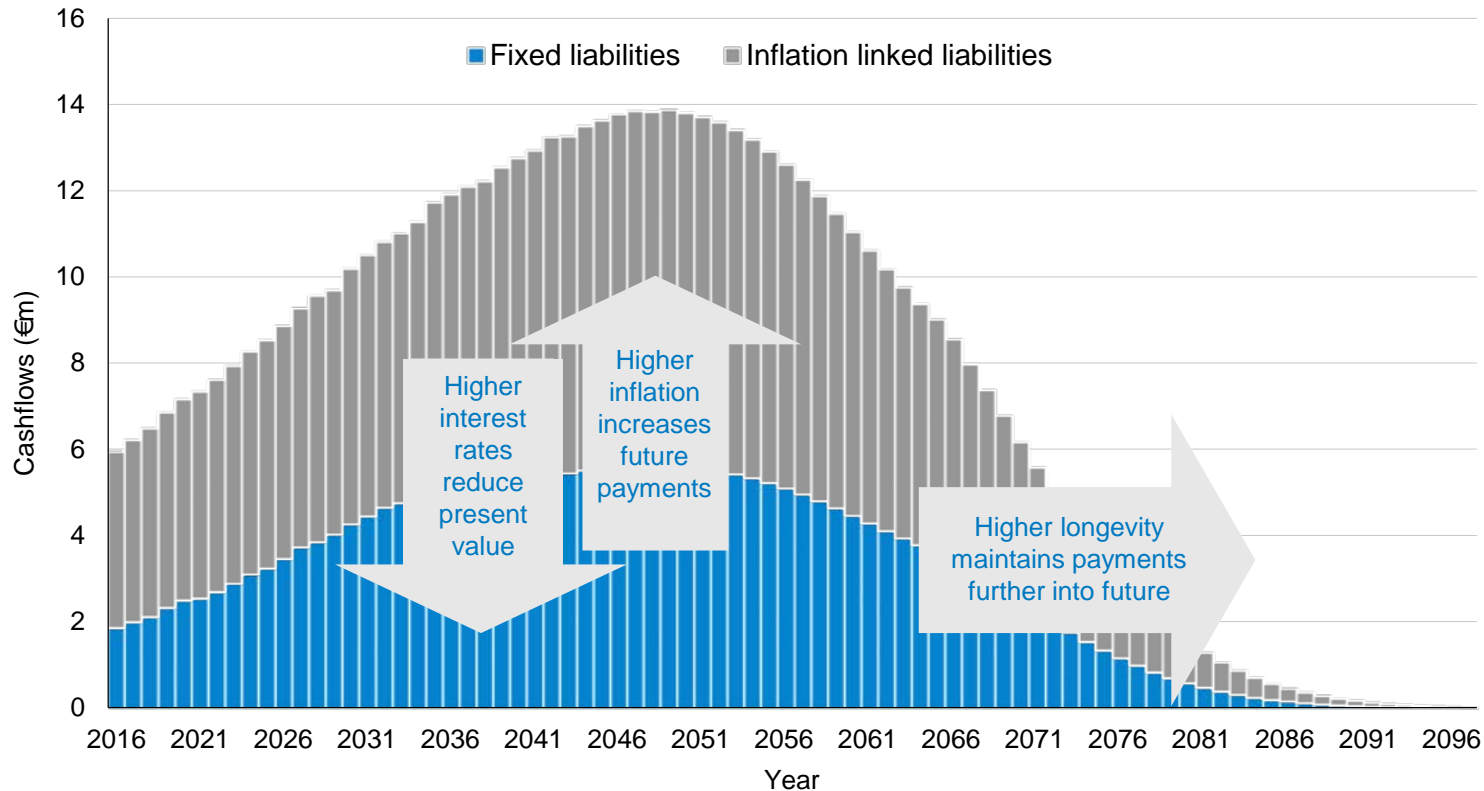
Cash flow to be paid in 20yrs



Source: BMO Global Asset Management. For illustrative purposes only

Liabilities of a defined benefit pension scheme

Factors that affect the present value of scheme liabilities

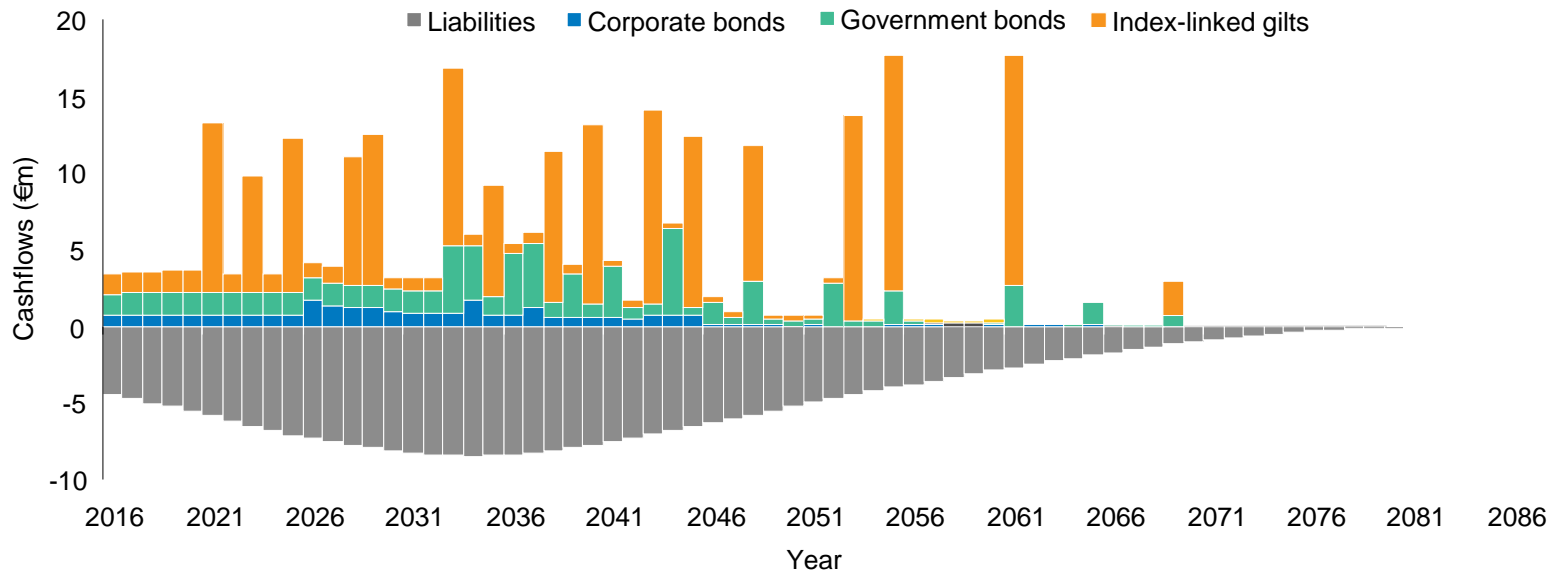


Source: BMO Global Asset Management. For illustrative purposes only

Matching a pension scheme's liabilities using bonds

Bonds have been the traditional hedging asset

Matching assets and liabilities



- Bonds can be used to match the fixed and inflation-linked liabilities with the following constraints:
 - Bond cash flows are lumpy
 - Long dated bonds are scarce
 - Inefficient use of capital in the long run

Source: BMO Global Asset Management

Swaps

A simplified example:

Fixed rate mortgage
3.0%

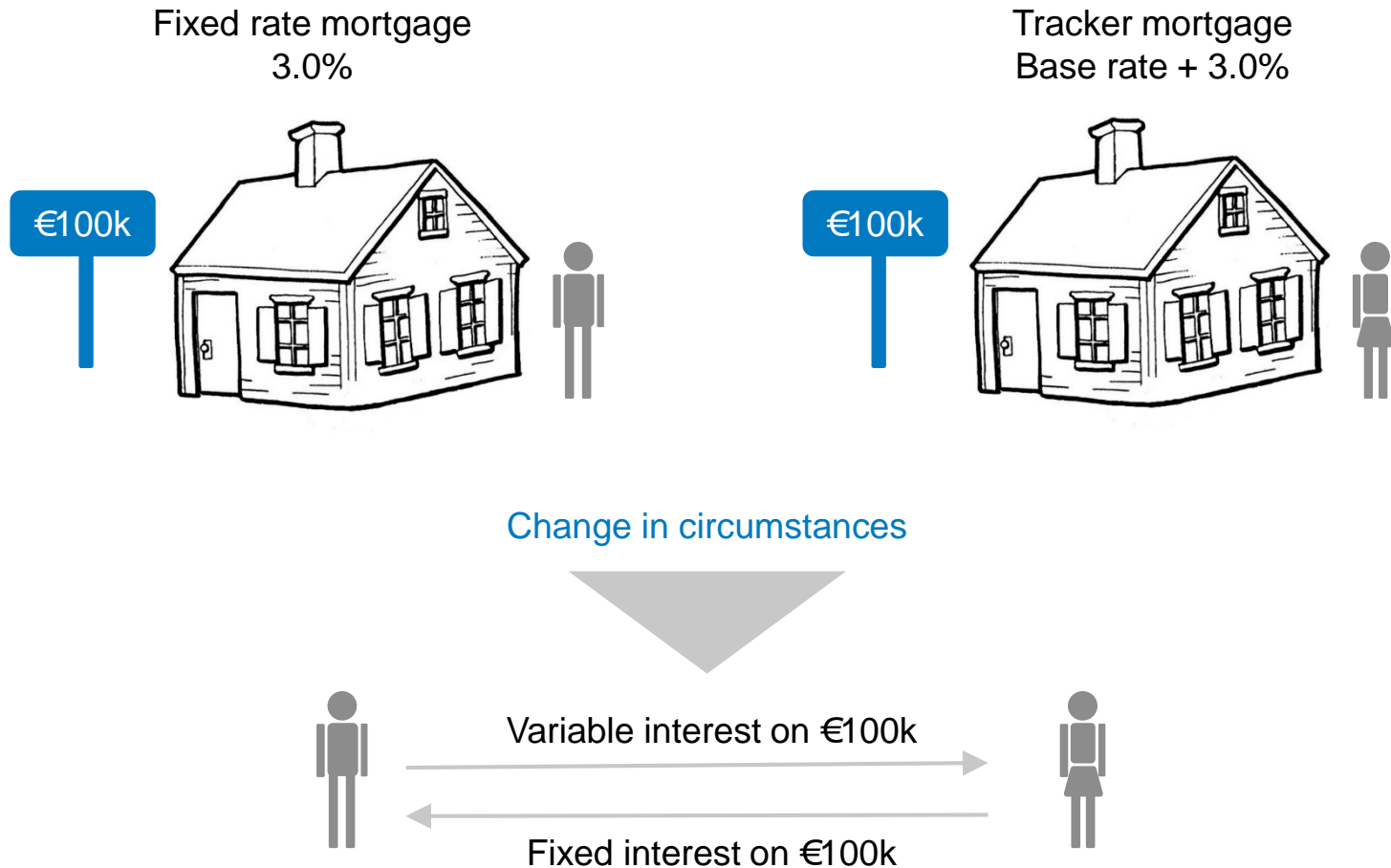


Tracker mortgage
Base rate + 3.0%



Swaps

A simplified example:



Matching using derivatives

	Current	Bond market up 20%
Liability value	<p>€300 Value today €600 Value in 20 years 3.5% interest rate</p>	<p>€360 Value today €600 Value in 20 years 2.6% interest rate</p>

Source: BMO Global Asset Management. For illustrative purposes only.

Matching using derivatives

	Current	Bond market up 20%
Liability value	<p>Value today: €300 Value in 20 years: €600 Interest rate: 3.5%</p>	<p>Value today: €360 Value in 20 years: €600 Interest rate: 2.6%</p>
Solution	<p>1 Match with bonds</p> <p>Cash: € Bonds: €300</p>	<p>Cash: € Bonds: €360</p>

Source: BMO Global Asset Management. For illustrative purposes only.

Swaps allow schemes to mitigate key risks without using up their assets

Matching using derivatives

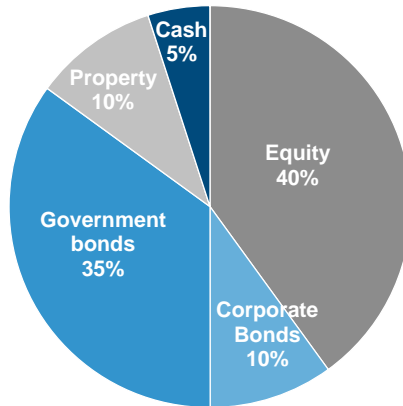
	Current	Bond market up 20%
Liability value	<p>€300 Value today €600 Value in 20 years 3.5% interest rate</p>	<p>€360 Value today €600 Value in 20 years 2.6% interest rate</p>
Solution	Current	Bond market up 20%
1 Match with bonds	<p>€ €300</p> <p>Cash Bonds</p>	<p>€ €360</p> <p>Cash Bonds</p>
2 Match with swaps	<p>€300 €</p> <p>Cash Swaps</p>	<p>€300 €60</p> <p>Cash Swaps</p>

Source: BMO Global Asset Management. For illustrative purposes only.

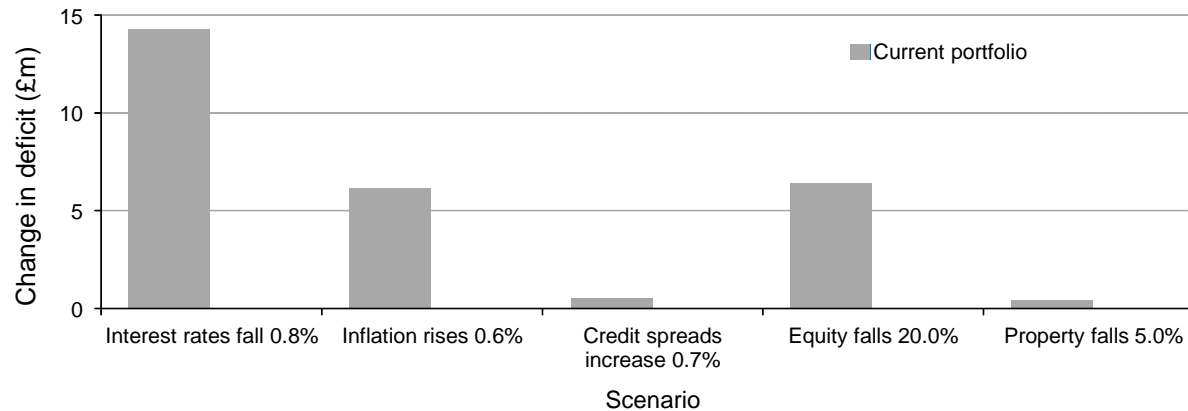
Swaps allow schemes to mitigate key risks without using up their assets

Risk reduction with LDI

Asset allocation



Effect of market changes



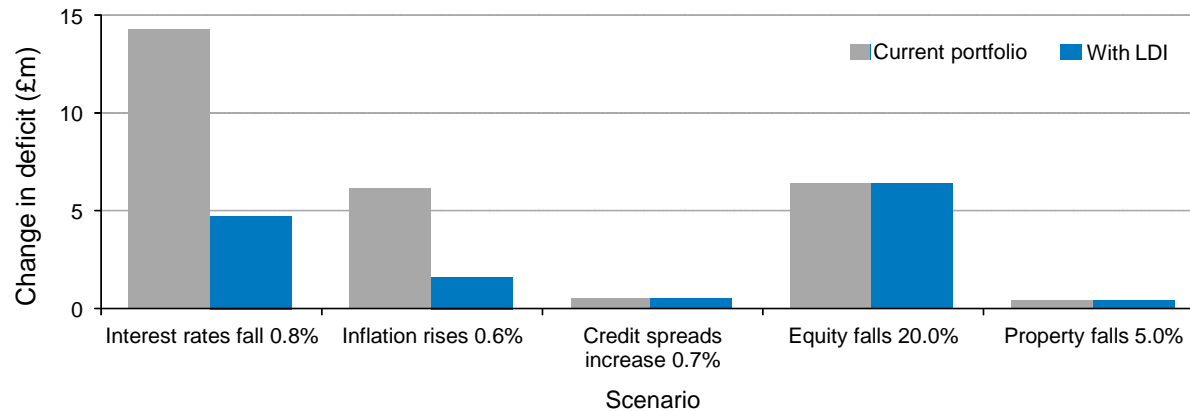
*Liabilities have a duration 22 of years and are 60% inflation-linked. Corporate bonds modelled using the iBoxx Sterling Non Gilts Index, gilts modelled as the FTSE Gilts 15+ Index and Index-linked gilts modelled as the FTSE Index-Linked Gilts 5+ Index. LDI modelled assuming a 100% hedge of the funded liabilities. Market moves modelled based on 5 years on monthly data to 30.06.2014

Risk reduction with LDI

Asset allocation



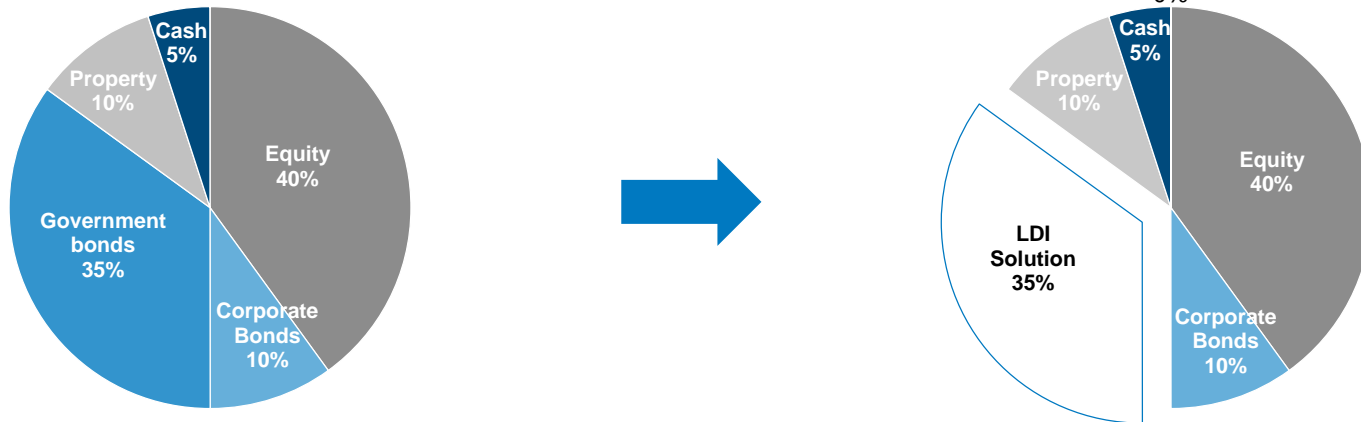
Effect of market changes



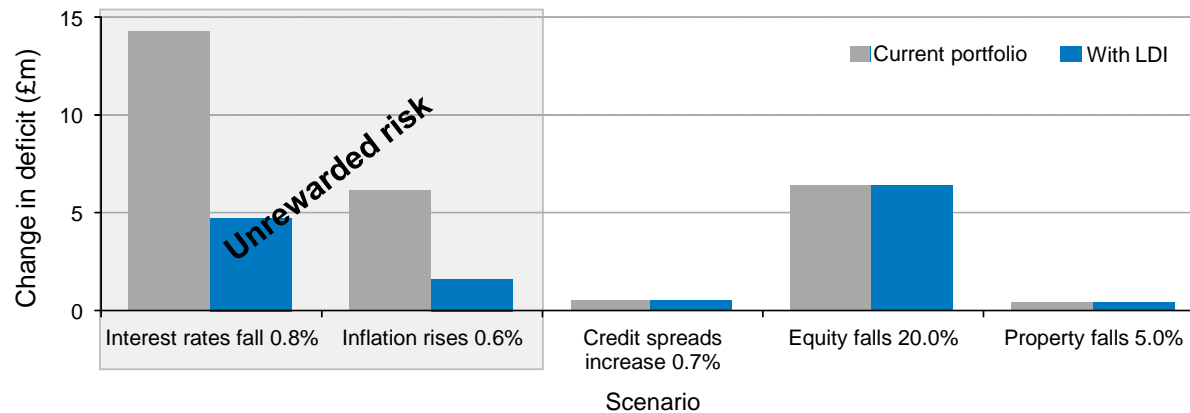
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Managing counterparty risk

Key risk management tools

- Centrally cleared positions:
 - Initial margin
 - Variation margin
- Traditional over the counter positions:
 - Counterparty vetting & monitoring
 - Daily collateralisation
 - Diversification

Derivative and repo counterparties



Clearing houses



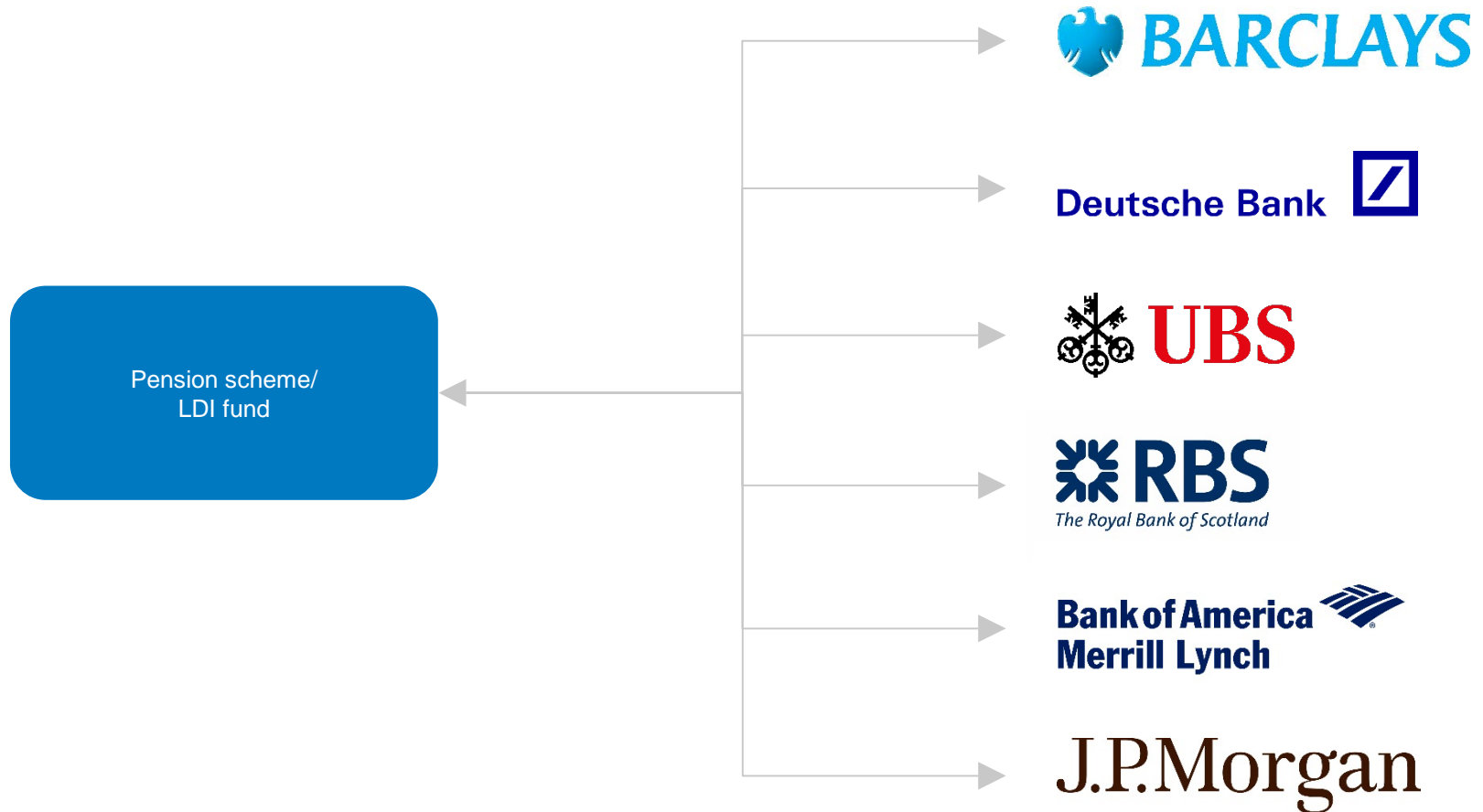
Derivative or repo counterparties



*Indicates that bank is one of BMO Global Asset Management's central clearing members
List of counterparty banks is subject to change.

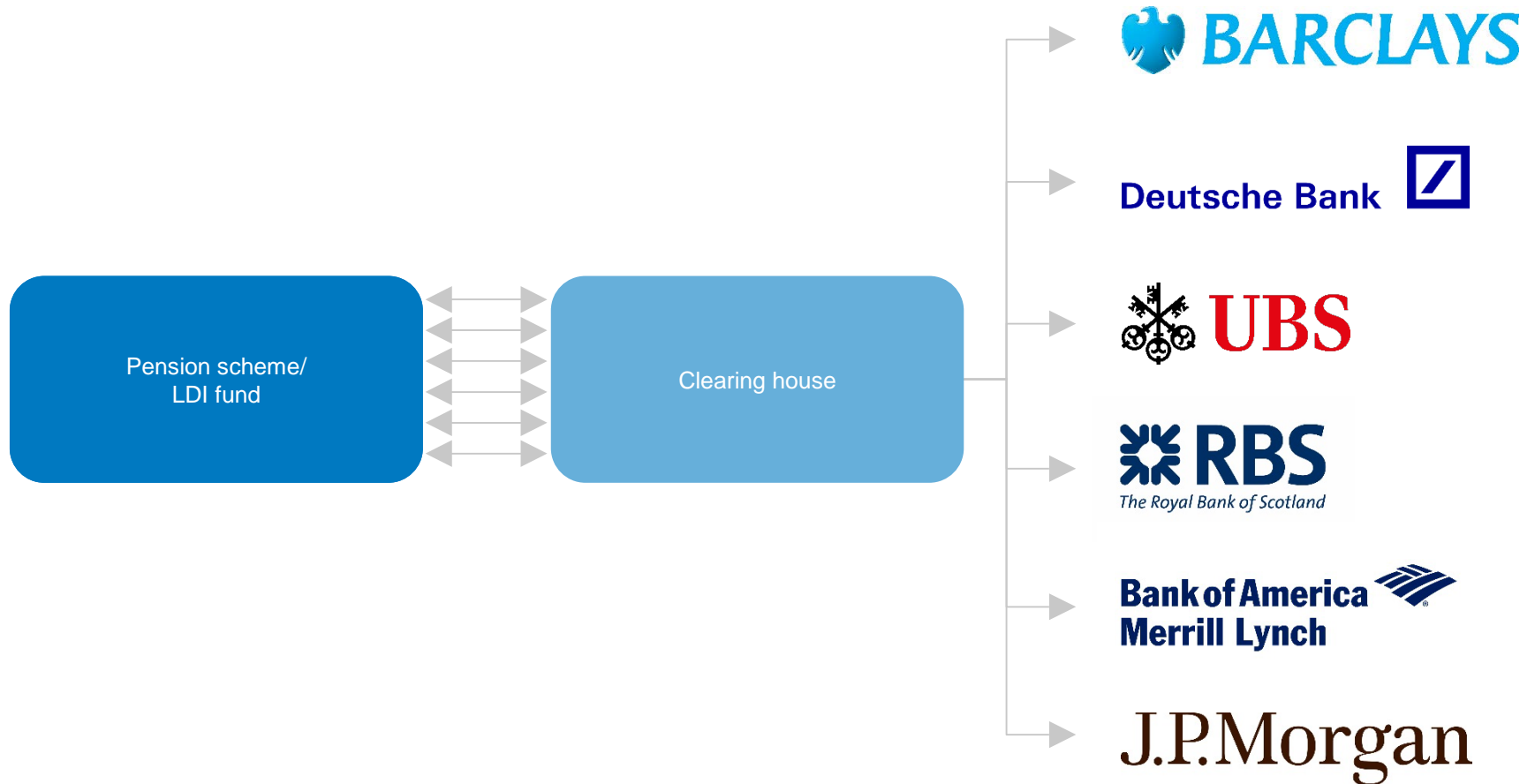
What is central clearing?

- Bilateral trades executed directly with the bank
 - Direct counterparty exposure



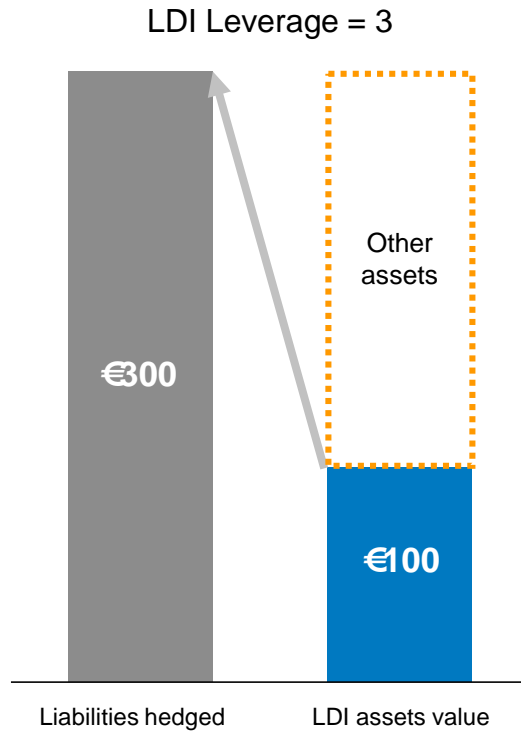
What is central clearing?

- Centrally cleared trades given up to the clearing house
 - No direct counterparty risk



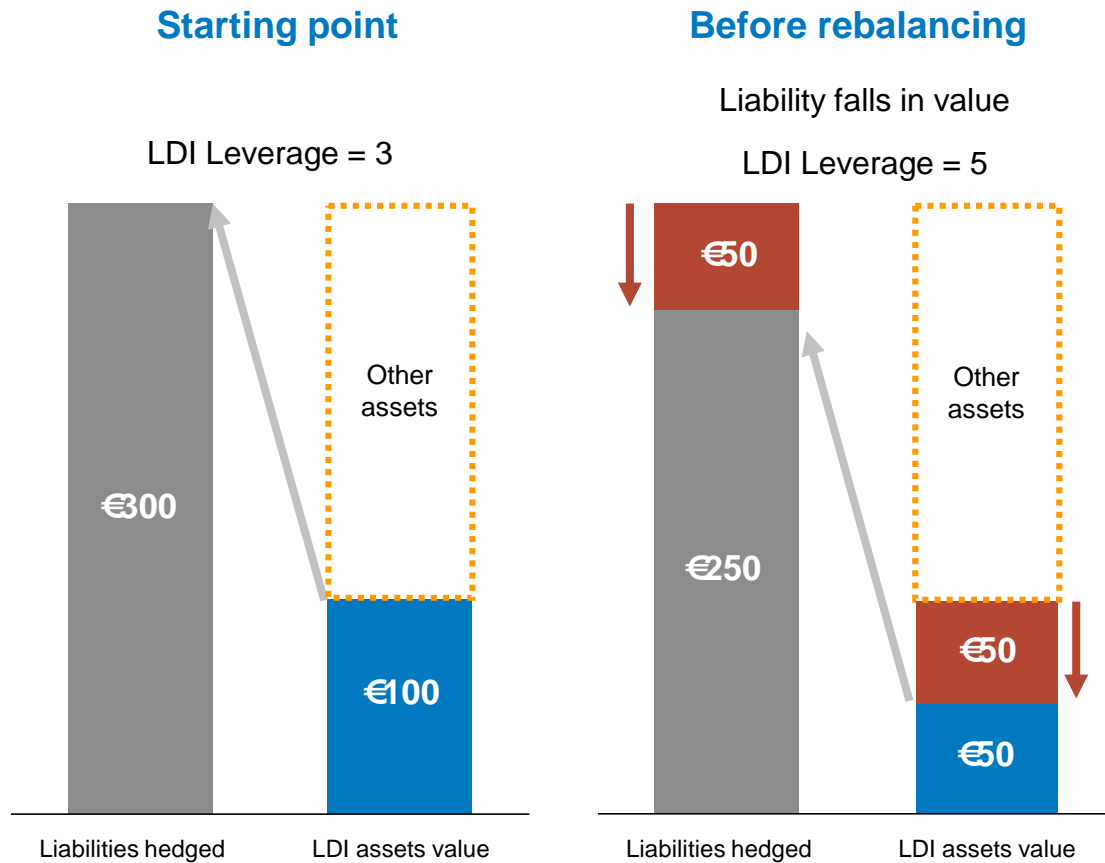
Monitoring and managing leverage

Starting point



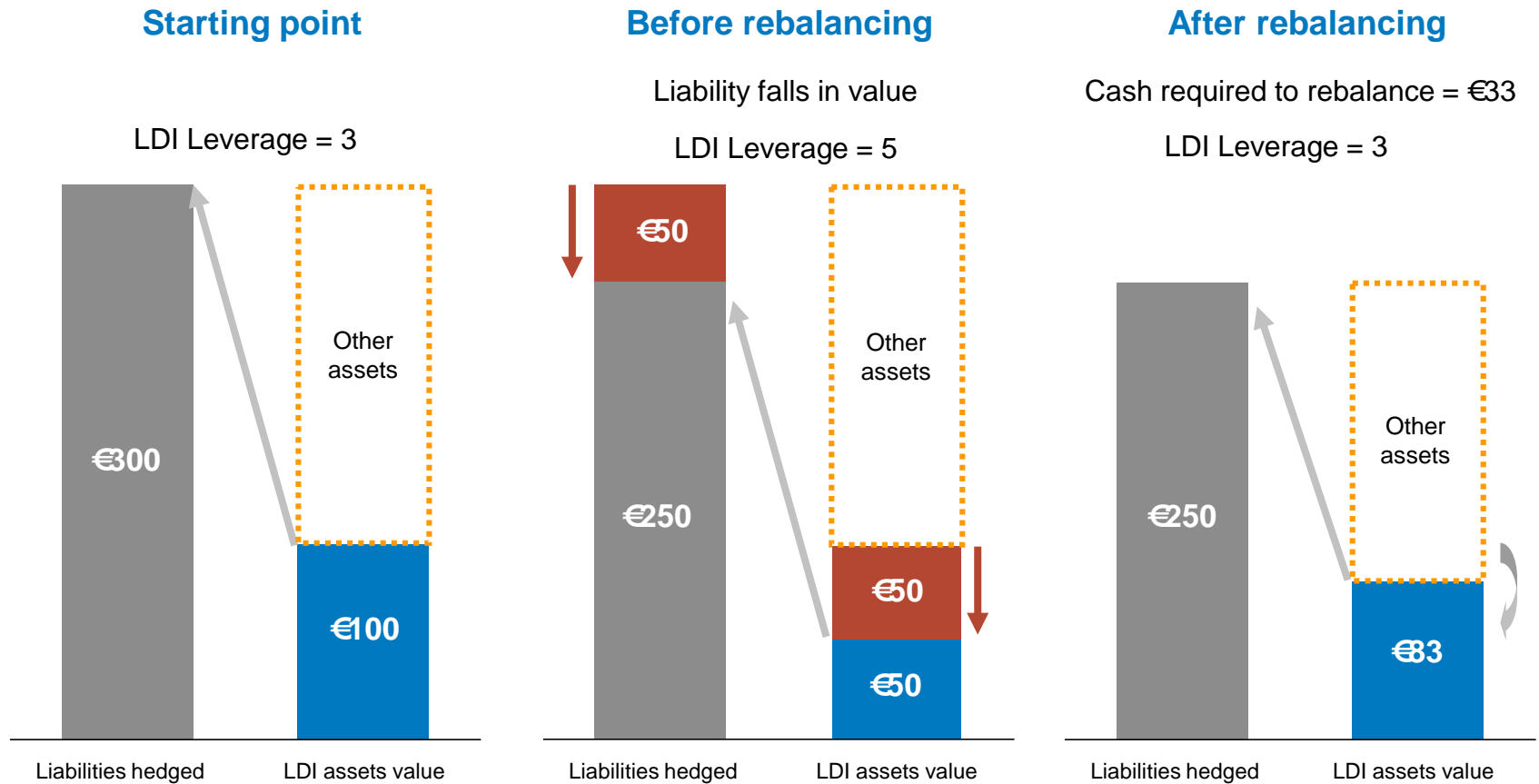
For illustrative purposes only

Monitoring and managing leverage



For illustrative purposes only

Monitoring and managing leverage

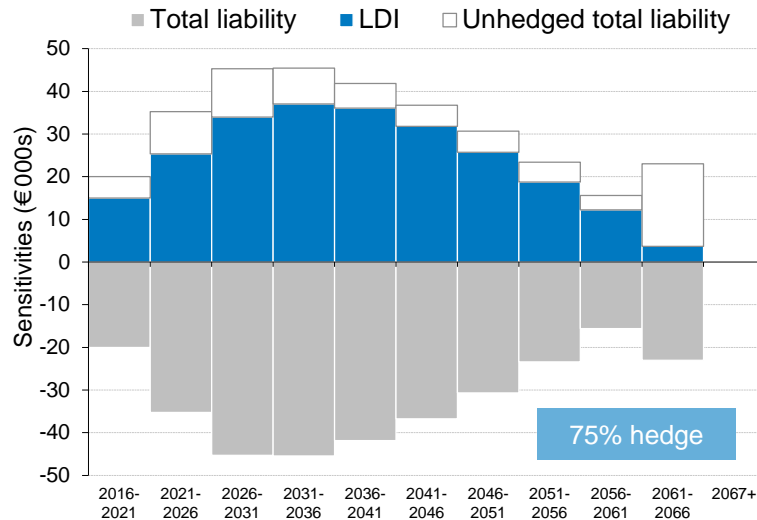


For illustrative purposes only

Putting theory into practice

Designing the LDI portfolio

Hedge portfolio analysis



- Interest rate sensitivity referred to as PV01 or DV01
- Inflation sensitivity referred to as IE01 or INF01
- Portfolio design should account for non-LDI bonds such as corporate bonds

Source: BMO Global Asset management, for illustrative purposes only

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Data requirements for implementation

Liability data
We require liability data in any one of the following formats:
Where cash flow data can be provided

<p>1) 3-dimensional cashflows. Cashflows split by member type, inflation hedge and tenor year</p> <p>Ideally these will have 0% inflation assumptions (regardless of caps and floors on inflation). If not we shall require the inflation rates to be used.</p>	<p>2) 3-dimensional cashflows. Cashflows split by member type and inflation hedge</p> <p>Ideally these will have 0% inflation assumptions (regardless of caps and floors on inflation). If not we shall require the inflation rates to be used.</p> <p>We shall split each cash flow in each tranche into pre-retirement and post-retirement increases, using a linear retirement run off table.</p>
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We will also require

- Details of the valuation basis to be hedged including
 - Discount rate
 - Assumption for deferred revaluation
 - Assumption for salary increases
 - Any HICP/local market inflation assumptions
- For 2) only: The average time to retirement (or use our own approximation)
- The most recent liability valuation would also be helpful but is not necessary

NB We shall use our own market derived rates (based on market rates and volatility) to determine the sensitivity of LDI [refer cash flows to HICP/local market inflation](#). Where a scheme's liabilities are sensitive to local market inflation (e.g. Irish inflation) which cannot be directly hedged with liquid instruments, our liability analysis will initially look at this local market sensitivity. We will then determine the most appropriate investable proxy (e.g. HICP) as well as the equivalent amount of proxy protection required.

Optional: To incorporate the actuary's assumptions we will need

- The curve for each type of inflation, under the neutral HICP/local market inflation assumption; and
- One of the following:
 - Their stated % relative sensitivity to HICP/local market inflation - inflated or uninflated.
 - The curve for each type of inflation with HICP/local market inflation adjusted by a fixed spread across the curve

3) **Blended proxy approach with primary's deltas**
Cash flows provided under two sets of inflation assumptions (not discounted) - preferably the assumptions used in the basis to be hedged and again with a fixed spread - or two fixed rates. This approach looks in the assumptions used by the actuary in their valuation of inflation sensitivity of cash flows linked to capped and floored inflation [see the valuation data](#). For example if difference between two inflation assumptions (the "spread") is 0.1% then inflation would move by 0.1% but a cashflow where the inflation was capped at 3% and floored at 0% would move by a smaller amount to take account of the effects of the inflation caps and floors.

We would also need:

- Details of the valuation basis to be hedged including
 - Discount rate
 - Inflation assumptions for all cases
- The most recent liability valuation would also be helpful but is not necessary

NB references to inflation can be to HICP or local market. Where a scheme's liabilities are sensitive to local market inflation (e.g. Irish inflation) which cannot be directly hedged with liquid instruments, our liability analysis will initially look at this local market sensitivity. We will then determine the most appropriate investable proxy (e.g. HICP) as well as the equivalent amount of proxy protection required.

BMO Global Asset Management

Page 2

- yearly interest rate and inflation
- MO with the yearly interest rate and larger in value given a 0.01% change (short respectively)
- ion - that is a cash flow linked to
- ear rates 'shocked' to arrive at the
- are sensitive to local market inflation (e.g. Irish inflation) which cannot be directly hedged with liquid instruments, our liability analysis will initially look at this local HICP) as well as the equivalent.
- h the characteristics of the Scheme's benchmark will be less accurate
- separately
- As if these are customised) plus

valuation.

- For leveraged products, duration, investment type and details of any inflation-linkage
- Details of which assets are to be sold in conjunction with the LDI implementation - also, if the intention is to match the risk inherent in certain matching assets that are being sold confirmation of which assets are to be risk matched
- Details of any non BMO matching assets which will be purchased as part of the LDI implementation (for example, information about any additional allocation to credit, or a new asset class with rates or inflation exposure)

Other information

- What products / funds is the client looking to invest in and what are the immediate and longer term aims (in terms of levels of hedging)?
- Is there already a target date for investment?

BMO Global Asset Management

BMO's range of euro LDI funds

BMO's EURO FUNDS

EURO LDI SWAP FUNDS

Common EURIBOR targeting fund

Common LIBID targeting cash fund

LDI Nominal
2021

LDI Nominal
2026

LDI Nominal
2031

LDI Nominal
2036

LDI HICPx
2036

LDI Nominal
2041

LDI Nominal
2046

LDI HICPx
2046

LDI Nominal
2051

LDI Nominal
2056

LDI Nominal
2061

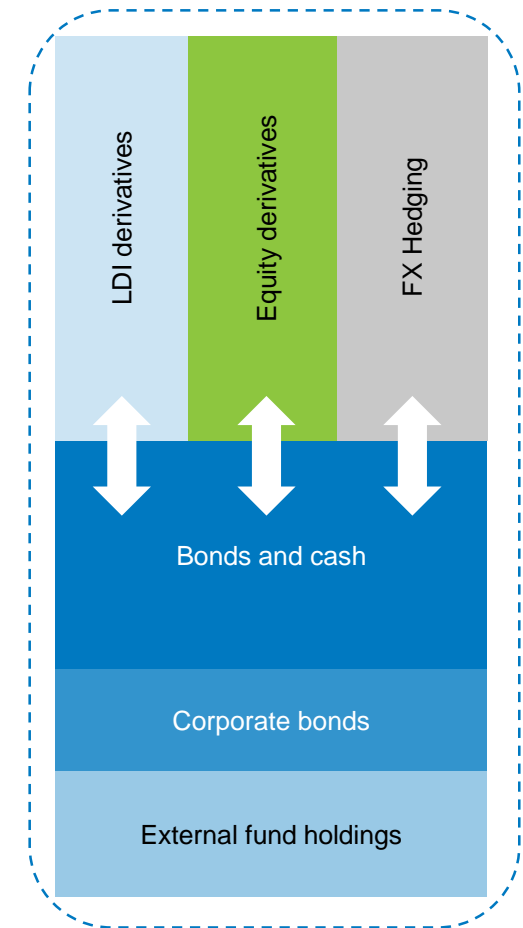
LDI Nominal
2066

- We launched our Swap fund products in 2006
- €1bn invested in EUR LDI swap funds
- Flexibility to protect against:
 - Real interest rates
 - Nominal interest rates
- The funds are leveraged around 3x on average
- Backed by conservative money market fund
- Rebalancing mechanism to prevent leverage becoming too high or too low
- Centrally cleared to reduce counterparty risk
- The funds have an independent custodian and fund administrator

Bespoke LDI funds

A unitised fund set up for the exclusive use of a single client

- Provides a segregated style solution
 - Without the need for a custodian
 - With a short lead time
- Unitised fund details:
 - Luxembourg domiciled Fonds Commun de Placement (FCP)
 - Fully ring-fenced sub-fund legal structure
 - No upfront set-up costs
- Derivative based strategies can be supported by efficient single collateral pool
- BMO Global Asset Management can easily:
 - Rebalance allocations to target
 - De-risk in response to intra-day triggers
 - Ensure ongoing collateral sufficiency
 - Add or remove investments in response to client instructions



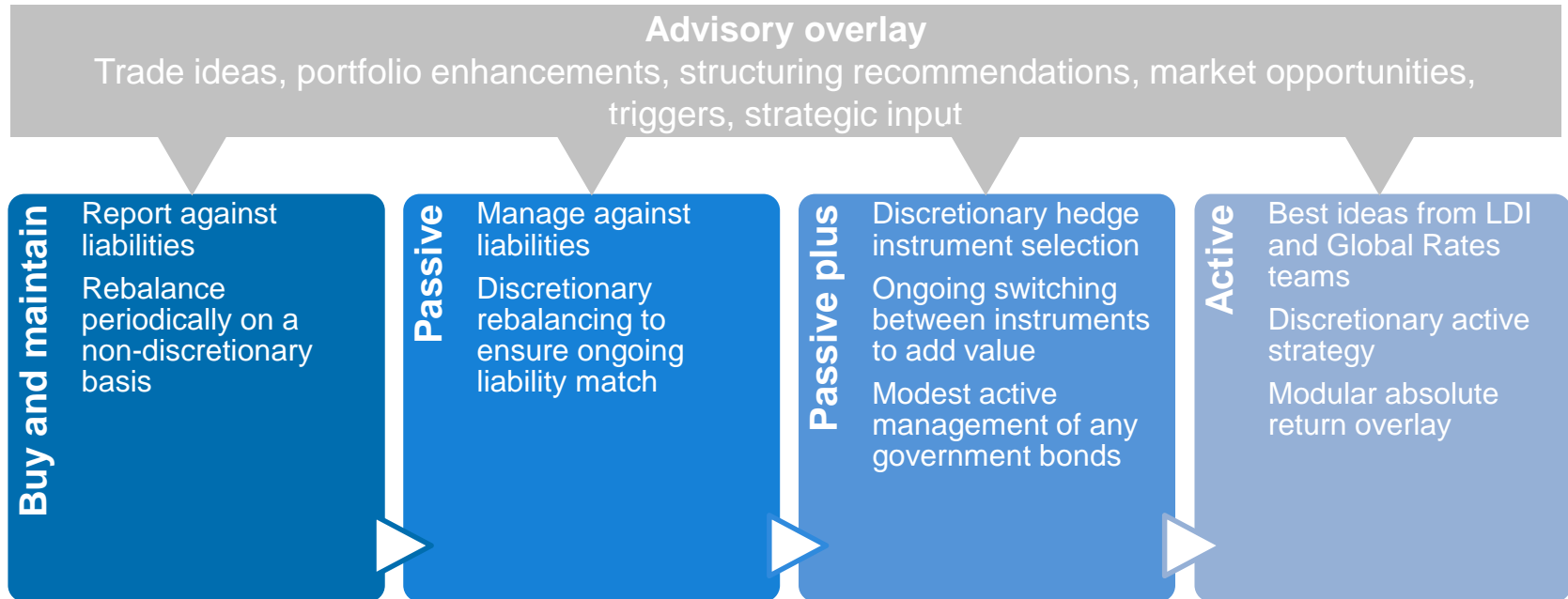
Creating the right portfolio structure

	LDI pooled funds	Segregated portfolio	Bespoke fund
Lead time	Short	Long	Medium
Ease of implementation	High	Medium	High
Hedging instruments	Swaps	Swaps and bonds	Swaps and bonds
Ease of monitoring	High	High	High
Hedge accuracy	Good	Excellent	Excellent
Flexibility	Limited	Excellent	Excellent
Typical min investment	€1m	€100m	€100m

- LDI manager can provide guidance as to the most appropriate portfolio structure

The range of segregated/bespoke management approaches

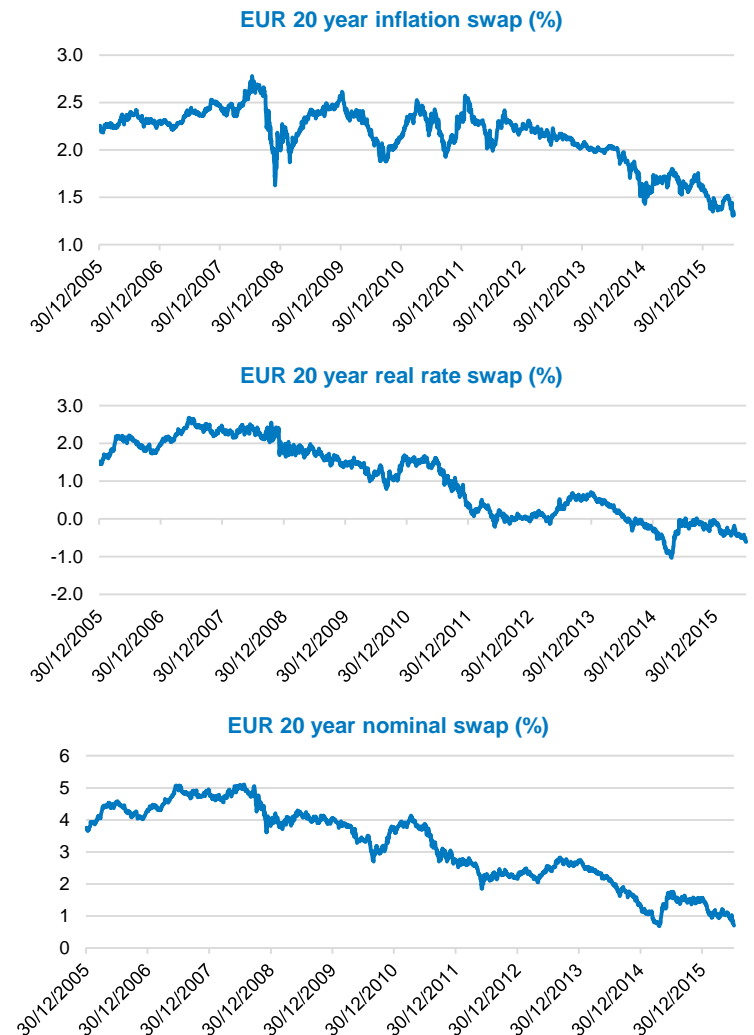
Each portfolio is tailored to the client's unique requirements



- Core LDI portfolios typically take one of the forms illustrated above
- Non-core derivative strategies can be combined with the above including: swaptions, synthetic equity, equity protection, volatility controlled equity, FX, synthetic credit

Expanding the hedge - trigger monitoring

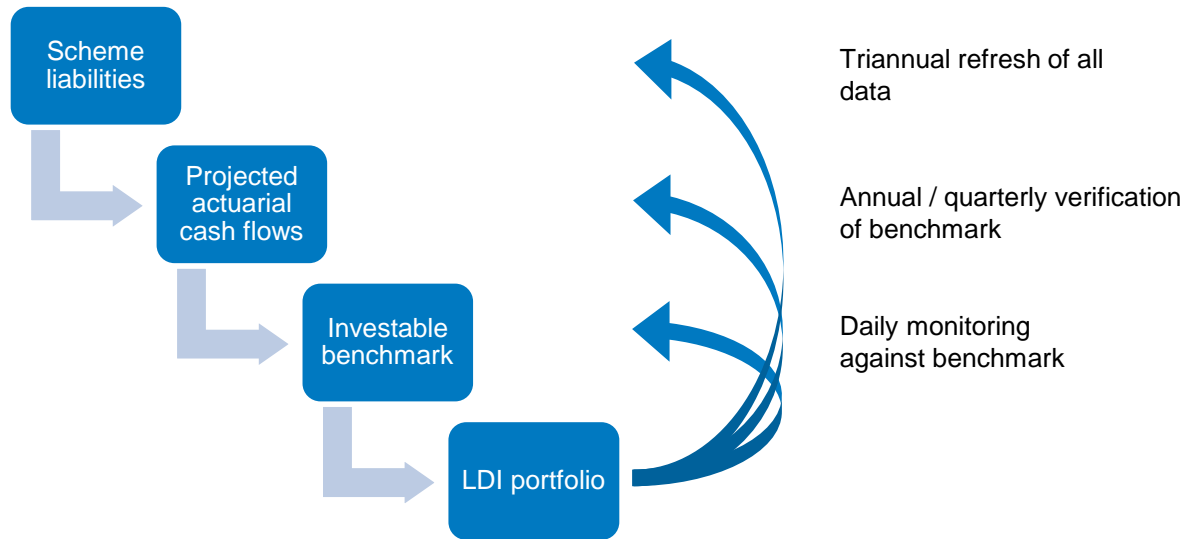
- Flexibility to monitor a wide range of trigger types
 - Funding level triggers
 - Yield-based triggers
 - Swap rates
 - Bond yields
 - Best of both
- We currently monitor over 100 separate triggers
- Advice on trigger levels and structure
- Regular review of triggers to ensure ongoing suitability



Triggers can be monitored daily, in real time

Source: BMO Global Asset Management. Bloomberg

Maintaining the effectiveness of the hedge



- LDI is not a fire and forget strategy – ongoing monitoring is important
- Get the right people doing the right jobs – delegate where possible
- Balance cost with accuracy

Considerations for the Irish market

LDI considerations for an Irish Pension Fund

Stabilising the funding ratio

- Key strategic questions:
 - What liabilities?
 - How much to hedge?
- Key implementation questions:
 - Assets to use?
 - What inflation best matches liabilities?
 - When to hedge? e.g. based on affordability
 - Set triggers to automate?

Ongoing liabilities

- Determined by the Scheme Actuary
- Can be hedged by investing in appropriate bonds and/or swaps

Funding Standard (MFS)

- Defined by The Pensions Authority
- Ability to hedge limited to proportion linked to market interest rates
- “Investibility” increases as maturity of scheme increases
- Include Risk Reserve

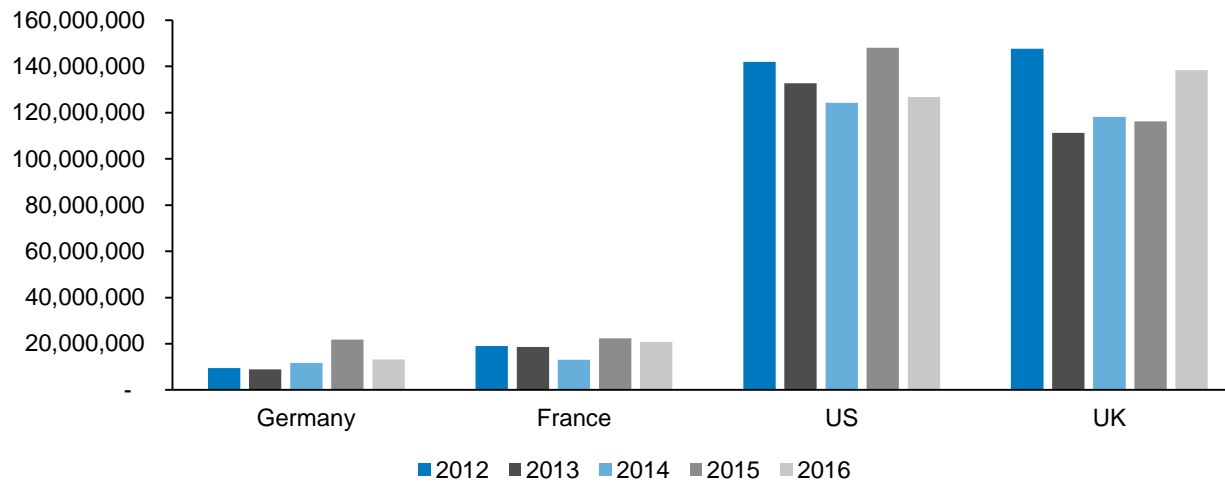
10% x (MFS liabilities less bond assets and cash)
plus

Change in value of MFS liabilities less change in value of assets, if a 0.5% fall in interest rates

Hedging inflation

- Scheme liabilities linked to Irish CPI or similar
- Limited market for Irish inflation-linked instruments

Gross inflation linked government bond issuance (euro PV01)



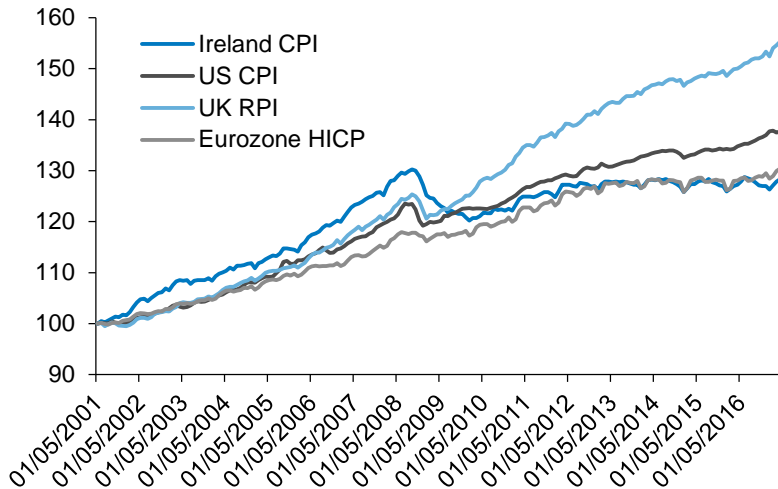
- First ever Irish inflation linked bond issued April 2017!

Source: Bloomberg. PV01 – the impact of a 0.01% change in interest rates

Hedging inflation

- Eurozone inflation (HICP) is a sensible proxy given common currency
- Active management can additionally look at the relative value between the main inflation markets

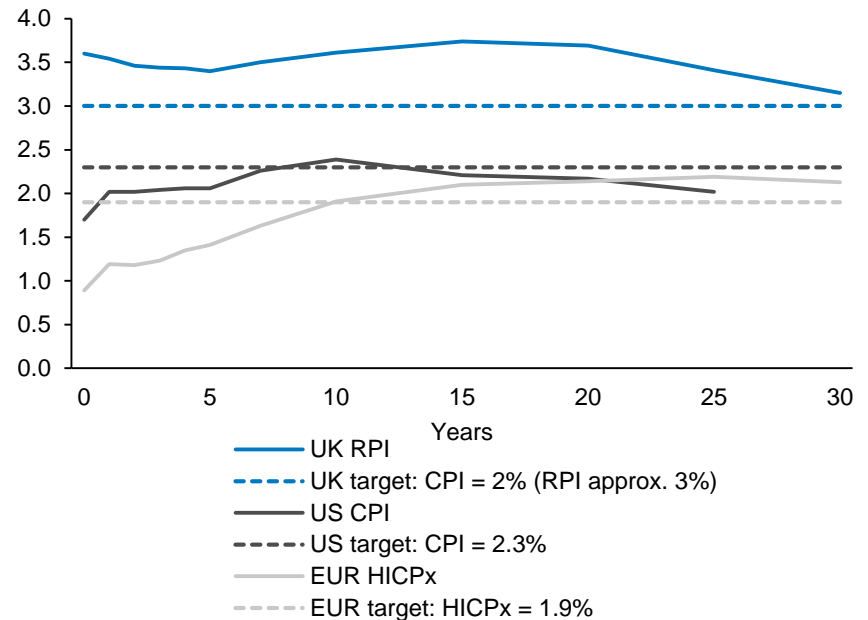
Regional inflation indices (rebased)



Correlation with Irish CPI since 1 May 2001

	US CPI	UK RPI	Euro HICP
Correlation	93%	88%	92%

1 year inflation forwards vs central bank targets (%)



Source: Thomson Reuters Eikon, Bloomberg. As at 15.05.2017

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Disclaimer

Past performance should not be seen as an indication of future performance. The value of investments and income derived from them can go down as well as up as a result of market or currency movements and investors may not get back the original amount invested.

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Extensive worldwide investment capabilities

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- Comprehensive range of products and solutions
- Defined expertise – including a suite of specialist investment boutiques



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