Liability Driven Investments in Retirement Solutions

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Agenda

● Liabilities as a benchmark in DB and DC

● Building a Liability Driven Portfolio in DB
  – Some principles
  – Case study

● Building a Liability Driven Portfolio in DC
  – Some principles
  – Case study

● Governance structure

● Conclusion
LIABILITIES AS A BENCHMARK
LDI: Liabilities as benchmark

- Individuals and Institutional investors (like insurance companies and pension funds) have future financial obligations (for retirement or towards their policy-holders)

- For each individual this translates into (a best estimate of) future cash flows to be paid to the policy holders

- So, each individual has its own liability-profile \(\rightarrow\) requires a tailor-made solution (DC)

- Aggregation over all individuals results in the total future liabilities of a pension fund or insurance company

- This leads to an combined/aggregated liability-profile \(\rightarrow\) requires a tailor-made solution (DB)

- In both cases, one of the main objectives of the investment portfolio is to generate a stable excess return over the liabilities without taking excessive risk

- This implies that the asset-portfolio has to be managed against the liability profile which makes the liabilities the benchmark of the investment portfolio (Liability-Driven Investing)
Liability Driven Investing: Universal Portfolio (DB/DC) Composition

Portfolio = (Synthetic) replication of liabilities + Generation of excess return over liabilities

- **Matching Portfolio**
  - Fixed Income products
  - Replication with funds

- **Return Portfolio**
  - Physical return portfolio
  - Alpha and Beta

**Overlays: Interest Rate, Inflation, FX, TAA**

Portfolio has different elements, each serving a specific purpose:

- **Liability Matching portfolio**
  - Low risk, passive or enhanced portfolio

- **Generating excess return over liabilities**
  - Diversified portfolio, actively or passively managed (all asset classes possible)

- **Overlays**
  - Hedging of unrewarded risks (interest rate, inflation, passive FX hedge)
  - Alpha strategies on portfolio level (TAA, active FX strategies)
Dynamics of the liabilities (DB/DC)

- The evolution of the liability-value is driven by two main factors:
  - “Actuarial” changes:
    - Change in number of policy holders (lapses / new business)
    - Change in life-expectancy/annuity-duration of the policy holders
  - Market-driven changes:
    - Change in discount-curve/valuation methodology
    - Realised profit (profit-sharing) / “realised” inflation
    - Changing time-to-maturity (time-value)
- Sensitivity to market-driven changes can be (partially) hedged
  - Mitigating risk for policyholders
Valuation of the liabilities (DB/DC)

- Shape of the liability profile typically depends on the nature of the underlying (individual) liabilities.

- To make a fair comparison between cash flows with different maturity dates we all discount them back to today’s value (fair-value).

- The discounting methodology is normally prescribed by the regulator. Examples are:
  - Government (related) curve
  - Corporate (related) curve
  - Swap (related) curve

[Diagram showing liability cashflows and discounting methodology]

Source: BNP Paribas Investment Partners
Valuation of the liabilities (DB/DC) - example

- Present Value = 934.4 Mln
- Duration = 20.7 (sensitivity to changing discount yield, first-order derivative)
- Convexity = 303.4 (second-order derivative)
- Effective yield based on yield curve

- Value for 20 years annuity after retirement
- Duration = maturity until retirement + 10 years (20 equal annuities)
- Annuity for every 100 USD investment = x USD starting from retirement
- Discounted with risk free rate = reference annuity

Source: BNP Paribas Investment Partners
LIABILITY DRIVEN PORTFOLIO IN DB

Some principles
Liability Matching Portfolio DB: Objectives

- Liability matching portfolio assumptions:
  - Matches duration and convexity
    - Replication of all cash flows is hard / costly to implement
  - Return objective: benchmark return or enhanced benchmark return
  - Tracking-error budget: 0.5% - 1.5%

- In our approach a liability matching portfolio is a low risk portfolio
  - Liquid instruments
  - Use of derivatives only to mitigate risk

- Main risks for a liability matching portfolio:
  - Liabilities are discounted with the swap-curve
    - Performance (development of funding ratio) is measured against the swap-curve
    - Risk is measured against the swap-curve

- We therefore construct a matching portfolio with a (slightly) higher yield than the liabilities and a low tracking-error
## Hedging solutions DB

<table>
<thead>
<tr>
<th>Hedging Solutions</th>
<th>Fixed Income return enhancements strategies</th>
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<tbody>
<tr>
<td>Bonds</td>
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<td>Benchmark replication</td>
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<td>Duration match</td>
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<td>Dynamic cash flow match</td>
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<td>LDI Funds</td>
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<td>Bonds / cash + swap overlay</td>
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<td>Bonds</td>
<td>Active overlay strategies</td>
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<td>Benchmark replication</td>
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<td>Duration match</td>
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<td>Dynamic cash flow match</td>
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<tr>
<td>Swap overlay</td>
<td>Active Fixed Income portfolio</td>
</tr>
</tbody>
</table>
Long bonds in DB: pros and cons

Pros

- The duration profile of liabilities can be completely matched
- Suitable for virtually all institutional statutes & investment guidelines/restrictions
- Comparatively low volatility

Cons

- Duration matching requires assets equal to the liabilities’ NPV
- No hedge against inflation and longevity (limited hedge in the case of surplus)
- Comparatively high long-term funding costs
- Lack of bonds with maturity longer than 30 years
- Different underlying discount curve than liabilities (swap-spread risk)
Long bonds in DB: spread risk

Swap spread development

- Swap-spread = government yield -/- swap yield
- Increasing volatility of swap-spreads since the 2008 credit-crisis

Country Asset Swap Spread Overview

- In Europe non Euro investments can be considered, however....
- .... many countries show a negative spread
- Return objective under pressure

Source: BNP Paribas Investment Partners
Interest rate swaps in DB: pros and cons

Pros

- Liabilities’ duration matched by assets worth less than 100% of the liabilities’ NPV
- This frees assets for investments in higher-yielding assets
- Comparatively low long-term funding costs
- Same underlying discount curve as liabilities

Cons

- Statutes and investment guidelines should allow the use of derivatives
- Set-up time required for clients: Product knowledge / Documentation (ISDA, etc.) / Execution / Confirmation & Settlements / Valuation / Collateral calls
Interest rate swaps in DB: leads to some “leverage”

The underlying portfolio must generate a return higher than the stream of floating rates.

Swap + cash = synthetic bond

Duration of a swap = duration of the fixed leg.

Credit risk: only on the coupons, not on the nominal amount. Credit monitoring is important.
LIABILITY DRIVEN PORTFOLIO IN DB
Case study
Liability Matching Portfolio: Construction

- Segregated portfolio:
  - Every institutional investor has a different liability profile: tailor-made solution suits best
  - Very important part of the total portfolio: risk-averse

- Use of derivatives implies efficient collateral management

- Target return in line with liabilities (small outperformance), with tracking-error of max. 1.5%

- Not a trading portfolio
  - But we will continuously look for attractive opportunities to improve the risk / return characteristics of the portfolio

- 5 steps to construct the portfolio:
  1. Determine the nature of the portfolio
  2. Screening of the universe
  3. Choice of instruments in relation to collateral management
  4. Determine the optimal interest rate swap portfolio
  5. Final portfolio construction
1. Nature of the portfolio

- **Safe instruments:**
  - Excess return over liabilities is generated investing in the spectrum of AAA/AA rated bonds

- **Liquidity premium:**
  - Since the nature of the portfolio is to replicate the liabilities (this is not a trading portfolio) we can benefit in the matching portfolio from the liquidity premium in some AAA/AA sectors

- **Low risk**
  - As the relative risk of the portfolio is determined by movements in the swap-spreads and duration, we prefer to invest the largest part of the physical portfolio in government (-related) bonds with a short duration and to select government bonds and interest rate swaps for longer maturities

**Our solution benefits from positive asset swap spreads on the short side of the curve while hedging the long side of the curve**
2: Screening of the universe

- We propose to construct a portfolio of highly rated bonds:
  - Citigroup EuroBIG

- Since the tracking-error is caused by swap-spread movements we prefer not to invest in longer dated bonds:
  - Citigroup EuroBIG 1-12 years

- We prefer bonds that have some kind of double claim or guarantee:
  - Agencies, supra-nationals, covered of government guaranteed

- Within the above universe we search for the most interesting sectors:
  - Final Universe
3: Choice of instruments

- As we construct a portfolio with short duration bonds, we need interest rate swaps to extend the duration to that of the liabilities:
  - Bond portfolio has a duration of 5.5
  - Duration of the liabilities is 17.3

- For the interest rate swaps we need to pledge collateral if the market value of the swaps is negative:
  - We pledge and receive only Government Bonds for this purpose

- We estimate that we need to keep 40% of cushion for collateral:
  - Based on a maximum curve shift of approx. 2%
  - Realizing gains and losses in the derivative portfolio is the other option

- Collateral management is executed internally by a dedicated team
  - Set up of documentation
  - Execution
4: Swap instruments

- Mismatch between portfolio cash flows and liability profile:
  - Bonds are selected from the universe with a maturity 1-12 years

- Interest rate swaps (IRS) are used to mitigate the mismatch:
  - IRS have maturities up to 50 years
  - IRS have no spread risk versus the liabilities

- We use IRS to reduce the risk
  - Payer swaps for the short maturities and receiver swaps for the longer maturities
5a: Portfolio construction

- Select securities (enhance return):
  - Securities are selected within the universe based on fundamentals and spreads
  - Government (-related) bonds
  - Interest rate swaps

- Risk management (ex-ante)
  - Use of a proprietary model to fine-tune the IRS-overlay
  - Monitoring is done with BarraOne and proprietary tools

- Performance measurement
  - Attribution against risk factors

The last step is input to the first step. We continuously screen the universe on attractive investments based on performance and fundamentals.
5b: Characteristics example portfolio

Mismatch in different interest rate scenarios

Diversification-matrix

Tracking-error decomposition

Risk Source | Portfolio Risk | Benchmark Risk | Active Risk | % Active Risk
--- | --- | --- | --- | ---
Total Risk | 12.83 | 12.96 | 1.16 | 100.00%
Local Market Risk | 12.83 | 12.96 | 1.16 | 100.00%
- Common Factor Risk | 12.83 | 12.96 | 1.15 | 97.65%
- Term Structure | 13.27 | 13.27 | 0.32 | 7.61%
- Spread | 5.54 | 6.59 | 1.19 | 105.61%
- Factor Interaction | N/A | N/A | N/A | -15.58%
- Selection Risk | 0.18 | 0.00 | 0.18 | 2.35%

Source: BNP Paribas Investment Partners
LIABILITY DRIVEN PORTFOLIO IN DC

Some principles
Our approach is to consider DC as ‘Individual LDI’ (1)

Defined Benefit (DB) Pension Funds:
manage a pool of assets vs. combined liabilities, in order to cover the liabilities of individual pension scheme members (active, deferred and pensioners)

BNPP IP combines its expertise and experience in Liability Driven Investments (LDI), from research to actual portfolio management

Defined Contribution (DC) Plans:
individual members are responsible for allocating their own savings to cover their future liabilities

BNPP IP considers individuals should benefit from the same formalized investment framework as has been developed for DB funds. We call this “Individual LDI”

Individual LDI offers an optimal trade-off between the risks a DC-member is exposed to over the complete span of time (accumulation and retirement) versus an attractive upward potential in terms of pension income
Our approach is to consider DC as ‘Individual LDI’ (2)

Assets: balanced portfolio

- Return component: Mix of risky assets with a good risk-return trade-off relative to liabilities
- Matching component: Mix of safe assets for de-risking the portfolio

Liability

- e.g.
  - Final Value as high as possible at retirement date
  - Potential pension income during retirement as high as possible

Individual LDI offers an optimal trade-off between the risks a DC-member is exposed to over the complete span of time (accumulation and retirement) versus an attractive upward potential in terms of pension income

Source: BNP Paribas Investment Partners
Individual Investors and the LDI framework

Flexibility → “Defining appropriate glide-paths”

Possibility to:
- separate hedging portfolio vs. performance portfolio
- cater for different risk profiles
- offer both ‘off the shelf’ as well as ‘tailored’ offerings (‘Individual LDI’)
- adapt to changes in lifestyle

Return → “Return portfolio”

Objective:
- opportunity for upside

Possibility to:
- increase diversification of strategic allocation
- include mid-term views in strategic allocation (e.g. “smart benchmarks”)  
- include tactical asset allocation

Security → “Hedging portfolio”

Possibility to:
- include Risk Management
- consider different types of hedging portfolios depending on the nature of liabilities, partially driven by local regulations
- Peace of mind, we take care of hedging
Individual LDI: What do we wish to maximize/secure?

**Proposition:**
e.g. Maximize the annuity bought on average at retirement date

**Risk profile:**
e.g. (High) probability of an annuity paying back all nominal instalments increased by inflation (e.g. +2% annual assumption)

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**Assets**

- **Return portfolio:** Mix of risky assets with a good risk-return trade-off relative to liabilities
- **& Matching portfolio**

**Liability**

- **Annuity:** theoretical annuity defined according to (and changing with) interest rate conditions

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The glide-path is the appropriate dynamic mix of matching and return portfolio for the defined risk profile
Individual LDI: How is it implemented?

- DC members have different perceptions of risk during and at their retirement date:
  - some are interested in ‘protecting’ their investments (“insurance”)
  - others are more interested in ‘protecting the annuity purchasing power’ of their nominal investment s(“real income”)

- So, to optimally serve the DC-member s you need to offer 2 type of schemes:
  1. ‘protected’ profile with a formal guarantee on the invested amount (“insurance” provided by a guarantor)
  2. ‘income’ profile aimed to maximize the income stream that can be bought at maturity (within different risk profiles)

- This translates for each individual into an investment in 2 portfolios and a product dependent optimal “glide-path”

Maximising the annuity a member can buy at retirement date
Invest premium in a Performance Seeking Portfolio (PSP)

Protecting against adverse scenarios that reduce the future annuity a member can buy at retirement date
Invest premium in Liability Hedging Portfolio (LHP)

The allocation between PSP and LHP change on an individual basis according to a proprietary rebalancing algorithm
LIABILITY DRIVEN PORTFOLIO IN DC

Case study
DC Portfolio Construction

- **General Characteristics**
- **Objective** is to maximize the 20-year income that can be bought on the Participant’s retirement date (“Yearly Income”)
- **Time dependent approach**
  - employs a formulaic asset allocation dependent on the time left before the retirement date in order to progressively secure the Yearly Income (and thus hedges the conversion risk)
  - No lock-in feature, progressively securing the Yearly Income after retirement through the pre-specified rebalancing mechanism
- **Path dependent approach**
  - subject to a formulaic dynamic asset allocation based upon a CPPI methodology in order to protect the Target Yearly Income (and thus hedges the conversion risk)
  - The Target Yearly Income is equal to the 20-year income that could have been bought based on the market conditions prevailing at the time of investment
  - The lock-in feature increases the Target Yearly Income after retirement as a result of growth in the Account Value and any favourable changes in interest rates
- **Typical asset allocation for a participant**
  - Investment in the PSP
  - Investment in the LHP which has a ‘target’ date at (or close to) the targeted Pension Date
DC Portfolio Construction: the building blocks

Performance Seeking Portfolio (PSP)
- Objective: To benefit from the risk premium from higher yielding asset classes to achieve an attractive return for the participant (to protect against inflation)
- Portfolio has a fixed risk profile / fixed SAA
- Include Dynamic Asset Allocation and Tactical Asset Allocation (TAA)
- Building blocks: Active or Passive Funds or Mandates

Liability Hedging Portfolio (LHP)
- Objective: Hedging of future pension obligations or cash flows
- Liabilities = cash flows in the future (different maturities)
  - Number of portfolios with maturities that match with possible retirement dates: 2015, 2020, 2025, 2030, 2035, 2040
  - Each participant chooses the combination of funds that fit his/her retirement date
- Fixed Income instruments: duration in line with maturity of the portfolio

Based on these building blocks you can offer several different investment solutions based on different rebalancing algorithms
DC Portfolio Construction: use of PSP/LHP over time (example)

- A 52 year old employee, having his retirement in 2028, being a ‘neutral investor’ invests according to the following table (please note this is an illustrative example)

<table>
<thead>
<tr>
<th>YEARS TO RETIREMENT</th>
<th>15</th>
<th>10</th>
<th>8</th>
<th>5</th>
<th>3</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>% in PSP</td>
<td>62.5</td>
<td>57.5</td>
<td>50.0</td>
<td>42.5</td>
<td>35.0</td>
<td>27.5</td>
</tr>
<tr>
<td>% in LHP2035</td>
<td>25.0</td>
<td>27.0</td>
<td>31.0</td>
<td>35.5</td>
<td>41.0</td>
<td>45.5</td>
</tr>
<tr>
<td>% in LHP2040</td>
<td>12.5</td>
<td>15.5</td>
<td>19.0</td>
<td>22.0</td>
<td>24.0</td>
<td>27.0</td>
</tr>
</tbody>
</table>

Source: BNP Paribas Investment Partners

- For every individual the Solution indicates an investment in the PSP and in two LHPs with a periodic rebalancing according to a pre-determined schedule

- Combination of LHPs to match duration of annuity with duration of pension obligation (‘LDI approach’)

Source: BNP Paribas Investment Partners
Glide paths as a function of the yearly income at maturity

- Glide path designed by
  - Maximizing returns, hence the PSP weight
  - While controlling the downside risk of not protecting the liabilities, hence not decreasing too much the LHP weight

- Thresholds and preservation depend on the profile:
  - Cautious profile: CVaR at maturity 9X.X% on real yearly income at maturity (inflation = 2%)
  - Neutral profile: CVaR at maturity 9Y.Y% on real yearly income at maturity (inflation = 2%)
  - Offensive profile: CVaR at maturity 9Z.Z0% on optimal nominal yearly income at maturity

- Glide path “naturally” resulting from the benefits of “time diversification”:
  - When far from retirement, more risk can be taken
  - Because bad returns are likely to be compensated by good returns
Glide paths of our optimized profiles over time

- Risk budget directly related to the horizon of each target date sub-fund
- Risk budget defined homogeneously for all target date sub-funds: (C)VAR 9x.x% at maturity
- Rigorous recursive algorithm followed to design the glide path = mix of LHP and PSP
GOVERNANCE STRUCTURE
## Typical Governance Structure in a DB environment

<table>
<thead>
<tr>
<th>Board of trustees</th>
<th>Investment committee</th>
<th>Consultant</th>
<th>Fiduciary Manager</th>
<th>Custodian/Administrator</th>
<th>Accountant</th>
<th>Actuary</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALM</td>
<td>Decides</td>
<td>Advises</td>
<td>Independent ALM consultant advises and executes</td>
<td>Advises</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategic advice</td>
<td>Decides</td>
<td>Advises</td>
<td>Advise by independent advisor</td>
<td>Advises and implements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tactical advice</td>
<td>Decides on framework</td>
<td>Decides</td>
<td></td>
<td>Advises and implements</td>
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<td></td>
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<tr>
<td>Manager selection</td>
<td>Decides</td>
<td></td>
<td></td>
<td>Advises and implements</td>
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<tr>
<td>Portfolio construction</td>
<td>Decides and/or delegates to Fiduciary Manager</td>
<td></td>
<td>Advises and implements</td>
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<td></td>
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<tr>
<td>Portfolio implementation and trading</td>
<td>Decides, implements</td>
<td></td>
<td></td>
<td>Implements</td>
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<tr>
<td>Performance monitoring</td>
<td>Decides on framework and monitors</td>
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<td>Advises and implements</td>
<td>Implements</td>
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<td>Risk and compliance monitoring</td>
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<td>Implements</td>
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<td>Advises</td>
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<td>Advises</td>
<td>Implements</td>
<td>Advises</td>
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<tr>
<td>Reporting to client</td>
<td>Decides on framework</td>
<td>Advises and monitors</td>
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<td>Advises and implements</td>
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Source: BNP Paribas Investment Partners
### Typical Governance Structure in a DC environment

<table>
<thead>
<tr>
<th>Governance matrix</th>
<th>Employer</th>
<th>Consultant/platform provider</th>
<th>Employee</th>
<th>Asset Manager</th>
<th>Administrator</th>
<th>Insurer</th>
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<tbody>
<tr>
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<td>X</td>
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</table>

Source: BNP Paribas Investment Partners
CONCLUSION
Liability Matching in DB and DC schemes: conclusions

- The liability matching portfolio is built to efficiently mitigate the interest rate risk of the liabilities
  - Both in a DB environment and a DC environment
  - Both use the same kind of techniques

- The Liability Matching portfolio is constructed within a strict risk framework
  - Conservative portfolio: only government bonds of highly rated non-government bonds
  - Interest Rate Swap overlay used to mitigate risk and capture the long duration of liabilities
  - Optimized within the pre-defined risk restrictions

- Target return is depending on the situation
  - DB: slightly higher than the return on liabilities
  - DC: able to buy (the highest) annuity at retirement independent of level of interest rates

- Clearly defined process:
  - Strong risk management focus
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