The Island of Misfit Pensions

Thoughts on Hedging Non-traditional Liabilities

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Richard R. Ratkowski, CFA – *Director, Investment Strategies*

As a Director in our Investment Strategies group, Rick's responsibilities include developing custom strategies designed to meet client objectives; developing and implementing proprietary financial modeling and engineering tools; day-to-day oversight of our Strategic Portfolio Management Team; and assisting with product development and growth initiatives. He joined NISA in 2005 through the internship program. Rick holds a BS in Computer Science and Economics and an MS in Computer Science from Washington University in St. Louis.

Kevin D. Schuman, CFA – *Director, Client Services*

Kevin is a director in the Client Services Group. He is responsible for client interactions and assisting in the development and implementation of customized investment strategies. He also oversees NISA's liability analysis team which works with clients and their actuaries to estimate the liability's effective interest rate exposure, and NISA's Hedge Portfolio Management Team, which is charged with calculating hedge targets for completion mandates and other synthetic overlay programs.

Kevin joined NISA's Operations Group in 1999 and transitioned to the Client Services Group in 2000. He holds a BSBA in Finance from Saint Louis University and an MS in Finance from Washington University in St. Louis.

David G. Murad, CFA, ASA, CERA – *Senior Manager, Investment Strategies*

David is a member of the team that develops proprietary financial modeling and engineering tools used throughout NISA. He also supports NISA's Strategic Portfolio Management team which is charged with maintaining hedge strategies including completion portfolios and exposure management strategies.

David joined NISA's Investment Strategies Group in 2019. Prior to joining NISA, he was a Managing Director at Rocaton Investment Advisors, consulting for a wide variety of institutional clients on asset allocation, capital markets, liability-driven investing, and other investment issues. Prior to that, he was an actuarial consultant at Buck Consultants. He earned a BA in Statistics and Psychology from Rice University.

Topics

- Prevalence of Non-traditional Pension
- Actuarial Assumptions and Benefit Form
- Cash Balance Plans
- Floor-Offset Plans
- Other Non-traditional Plans

Cash Balance and Floor-offset Prevalence

All Qualified DB Plans with >$100mm Assets

	Cash Balance	Floor-Offset	All Plans
Count	665	70	2,635
% of Plans	25%	3%	
Assets ($bn)	1,076	142	2,978
% of Assets	36%	5%	

Source: Department of Labor, NISA Calculations. Estimated by NISA based on 5500 data for plan years ending in 2019. Cash Balance and Floor-Offset counts and assets are captured for plan filings that note the inclusion of any such provisions in the plan. These plans likely are not fully described by these provisions.

Actuarial Assumptions

Actuarial Assumptions

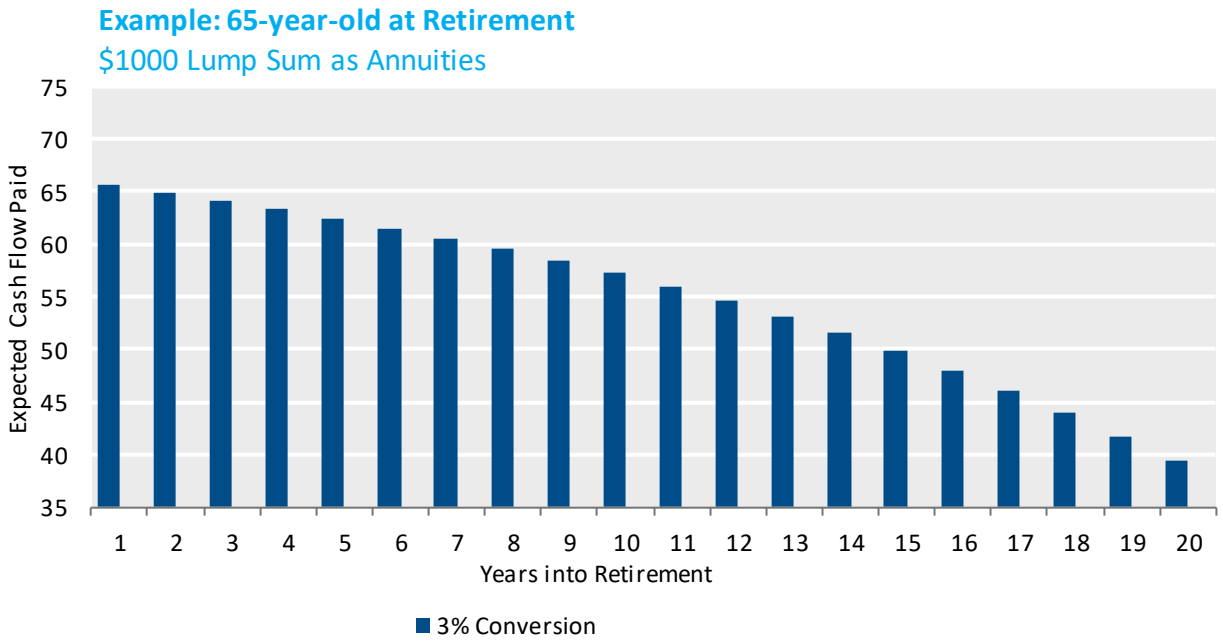
- Actuarial assumptions, which differ by liability, are meant to serve as reasonable long-term deterministic projections. Assumptions can include:
  - Mortality and other decrements
  - Benefit form elections
  - Wage increases
  - Investment returns
  - Interest rates, spreads, and inflation
- While assumptions are ideally calibrated for understanding the long-term cost, **assumptions do not determine the cost of nor necessarily reflect the economic sensitivities of the plan**.

Managing Risk

- **Liability risk management is generally viewed through an economic lens.**
  - What are markets telling us today?
  - What are forward-looking plan risk exposures?
  - Static longer-term assumptions may not capture prevailing market pricing.
- The purpose of a hedging program and the specific risks mitigated determine the appropriate liability.
  - Cash (contributions / PBGC premiums)
  - Balance sheet
  - Pure economic

Benefit Payment Forms and Why They Matter

- For both traditional and “misfit” pension plans, benefit form optionality presents more complex exposure to interest rates and credit spreads.
- In particular, conversions between annuities and lump sums are based on an assumption at the time of calculation of final benefits.
- Projections of future conversion rates at valuation (based on market pricing) may impact present value and duration and may differ from actuarial assumptions.
- The examples below illustrate how projected future payments change based on annuity-lump-sum conversion.



Source: NISA calculations. Based on male mortality from Pri-2012 mortality table scaled to 2022 with scale MP-2021.

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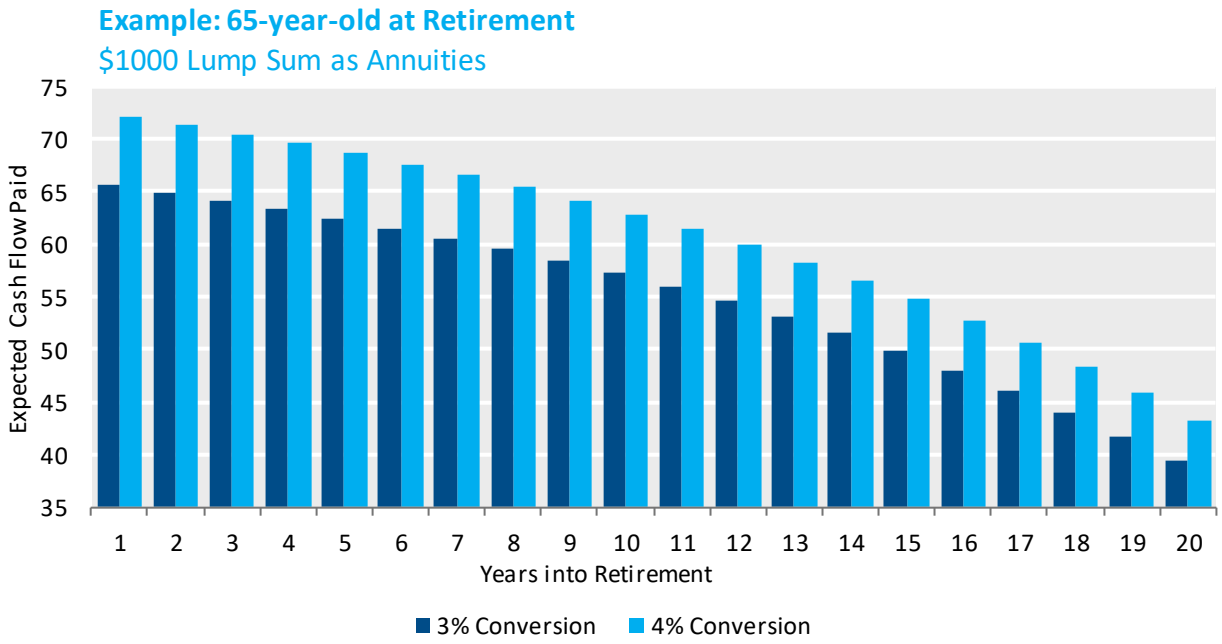

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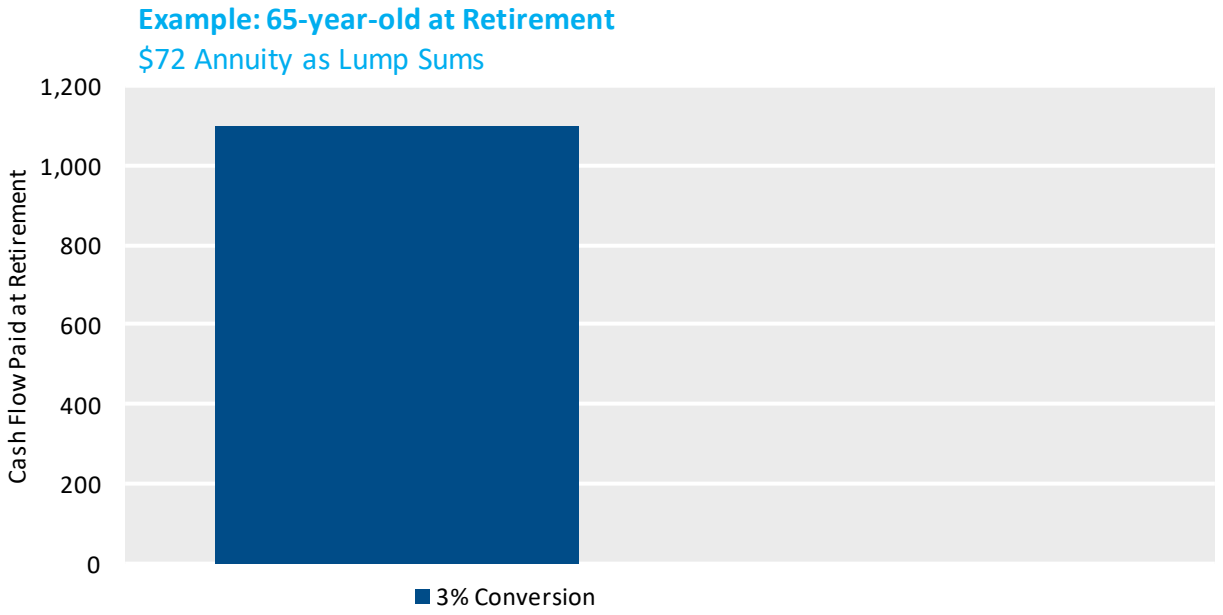

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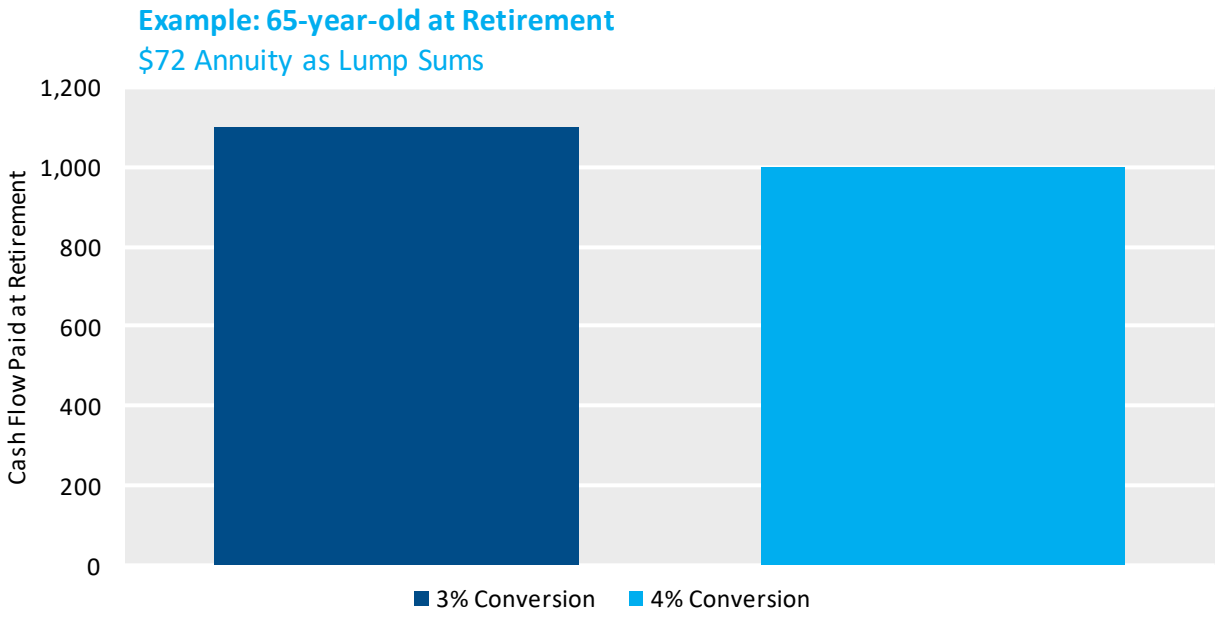

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Impact of Rate Move on Each Component in Isolation

Parallel Rate Move	**Up**	**Down**
Discounting	Liability Decreases	Liability Increases
Floating Crediting Rates	Liability Increases	Liability Decreases
Lump Sum → Annuity*	Liability Increases	Liability Decreases
Annuity → Lump Sum*	Liability Decreases	Liability Increases

*If conversion rates float.

Cash Flows for Hedging (Cheat Sheet)

Normal Form How benefits are expressed.	Payment Form How benefits are assumed to be taken.	Interest Crediting Rate (ICR) Does ICR change with markets (float)?	Lump Sum/Annuity Conversion Rate Does form conversion rate change with markets (float)?	Flows Desired for Hedging The appropriate type of cash flows for estimating the NPV and/or duration.
Annuity	Annuity	n/a	n/a	Annuity
Annuity	Lump Sum	n/a	Fixed	Lump Sum
Annuity	Lump Sum	n/a	Float	Annuity
Lump Sum	Lump Sum	Fixed	n/a	Lump Sum
Lump Sum	Lump Sum	Float	n/a	Lump Sum / NA
Lump Sum	Annuity	Fixed	Fixed	Annuity
Lump Sum	Annuity	Fixed	Float	Lump Sum
Lump Sum	Annuity	Float	Fixed	Lump Sum
Lump Sum	Annuity	Float	Float	Annuity / NA

Caveats (non-exhaustive)

- This is general — there is always greater nuance.
- This is for **parallel** changes in any floating rates, in tandem with discount rate changes.
- Actual benefit payments should be expected to be based on the Payment Form flows, not the Flows Desired for Hedging.
- For cash balance plans with an ICR floor, there is more nuance than above.

Lagging, Smoothing, Periodicity, Greater-of

- Benefit features may present exposures that are not based on prevailing market pricing.
- This creates optionality in the liability that is not reflected by looking at a static set of cash flows.

Feature	Examples
Lagged	Lump sum rates with a lookback
Smoothed	Averaged lump sum or cash balance interest crediting rates
Periodicity	Frequency of snap of lump sum rates or interest crediting rates
Greater-of	The “greater of” one benefit formula or another, often a Final Average Pay vs. Cash Balance formula

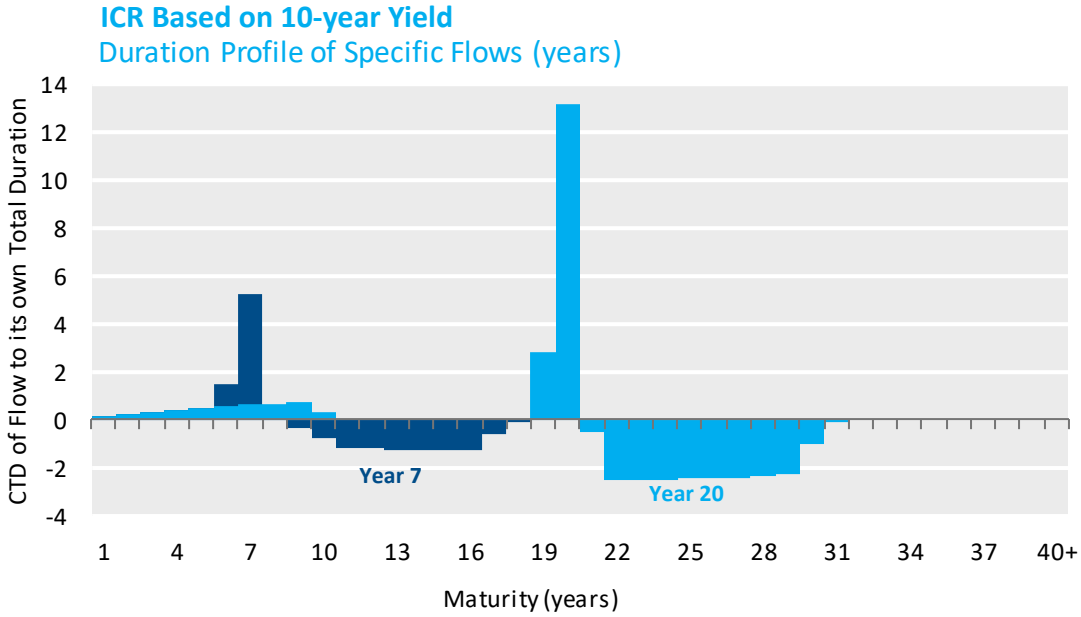
Cash Balance Plans

Range of Cash Balance Situations

Crediting Rate	Floor Feature?	Example Hedging Solutions
Fixed	N/A	Hedge like traditional pension
Floating	No	• Buy credit, short rate exposure with Treasury derivatives (accounting) • Long-short Treasury derivative hedge • Constant Maturity Swaps
Floating	Yes	• Dynamic target hedge ratio • Caplets
Greater-of Formula*	Sort of	Depends

*Plan designs may also combine this feature with the other features.

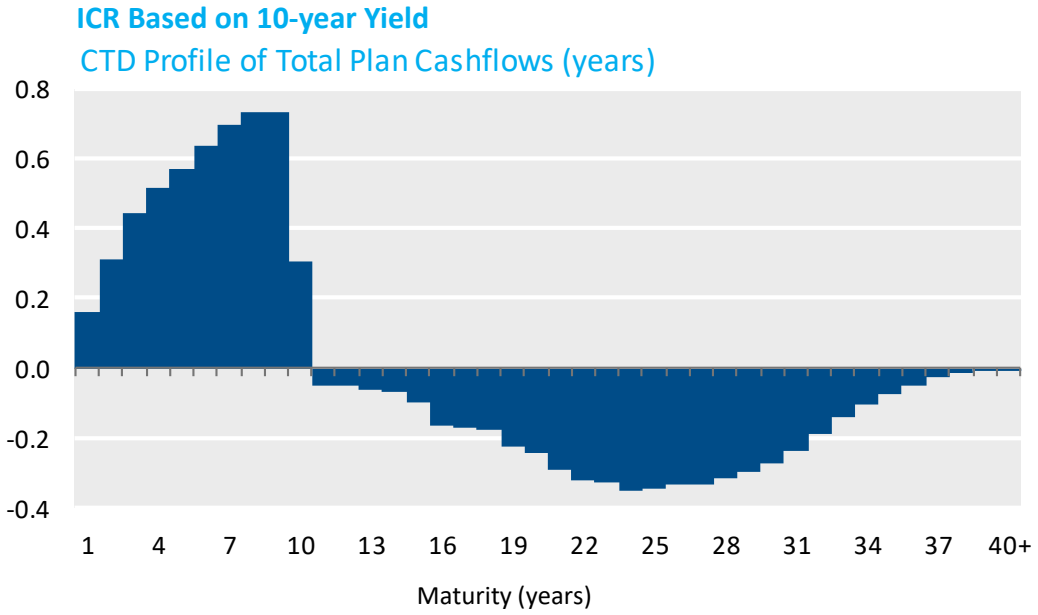
Curve Exposure – Floating Rate Cash Balance Plan (Individual Flows)



- From an economic perspective, each projected payment has ~0 year duration but has exposure to the curve with:
  - Some positive duration at/prior to payout maturity
  - Negative duration past the payout maturity
- Spread duration will be present when focusing on accounting statement impact.

Source: NISA Calculations. Illustrated based on a flat discount curve with no spread. Cash flows are assumed to be projected on a forward-implied basis bootstrapped from the underlying Treasury curve. CTDs (Contributions to Duration) are shown on a zero-duration basis.

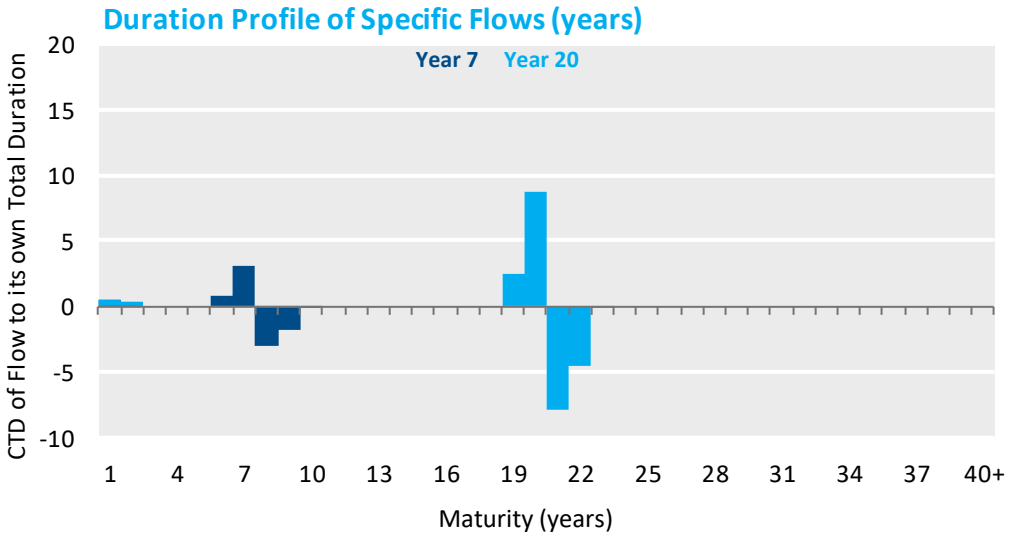
Curve Exposure – Floating Rate Cash Balance Plan (Total Flows)

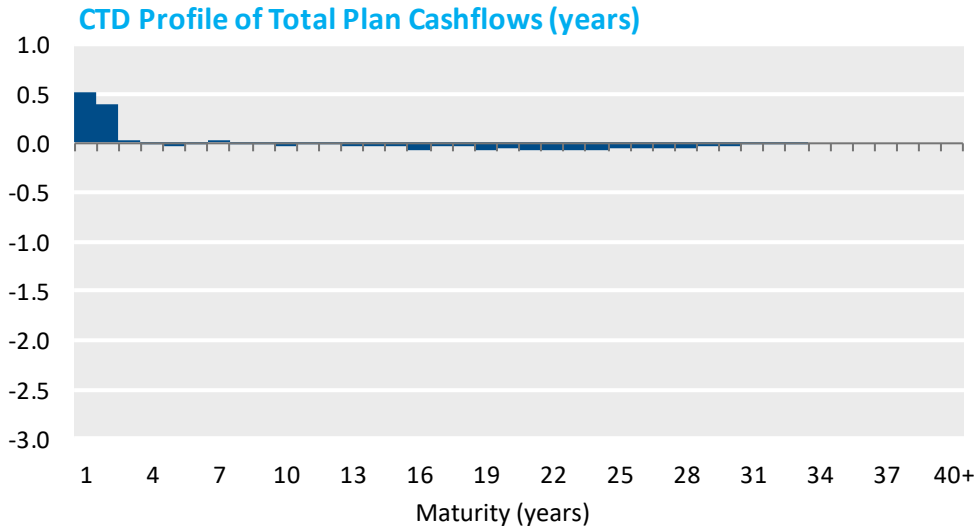


- As we bring all the flows together for a sample plan, the range of hedging solutions implied may vary for different ICR bases.
- All plans **imply some form of exposure to a curve steepener** (liability increases if longer rates increase relative to shorter rates).
- ICRs with a longer basis (30-year Treasury yield) may also provide substantial convexity exposure.

Source: NISA Calculations. Illustrated based on a flat discount curve with no spread. Illustrative static cash flows are based on a duration of 10.4 years. Cash flows are assumed to be projected on a forward-implied basis bootstrapped from the underlying Treasury curve. CTDs (Contributions to Duration) are shown on a zero-duration basis.

ICR Based on 2-year Yield





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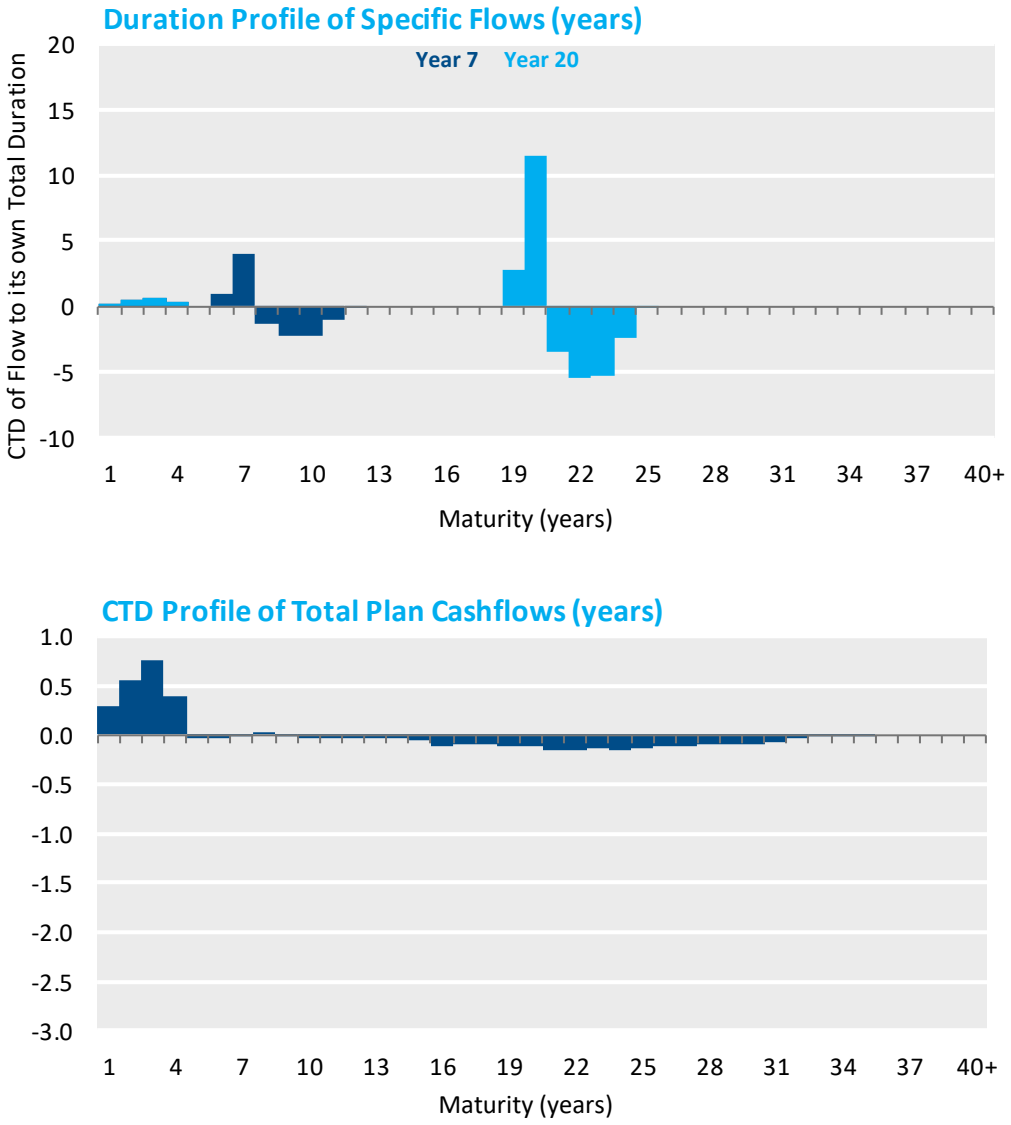
ICR Based on 4-year Yield



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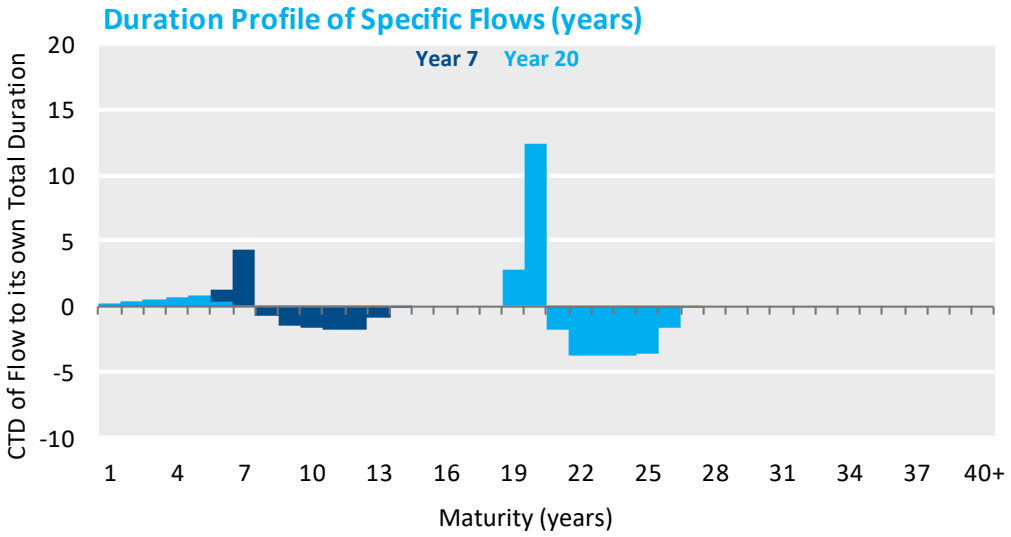
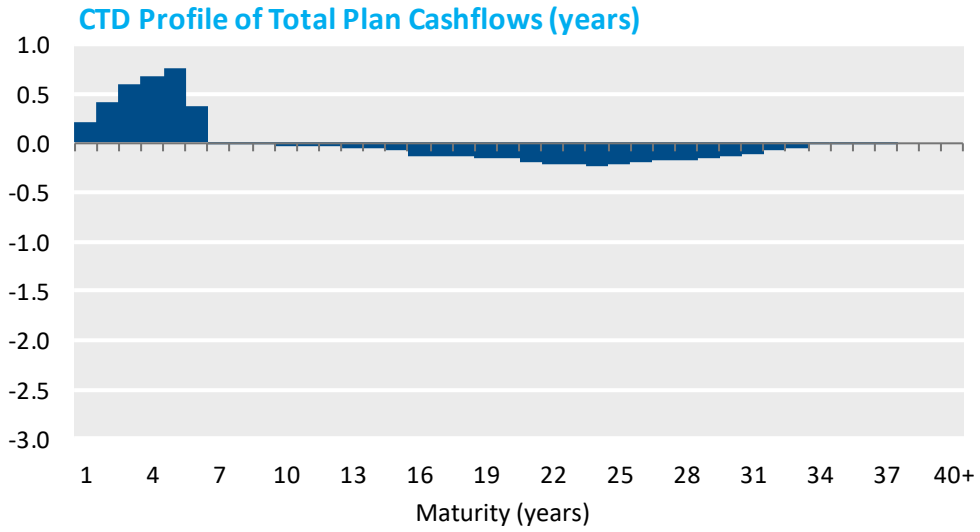
ICR Based on 6-year Yield





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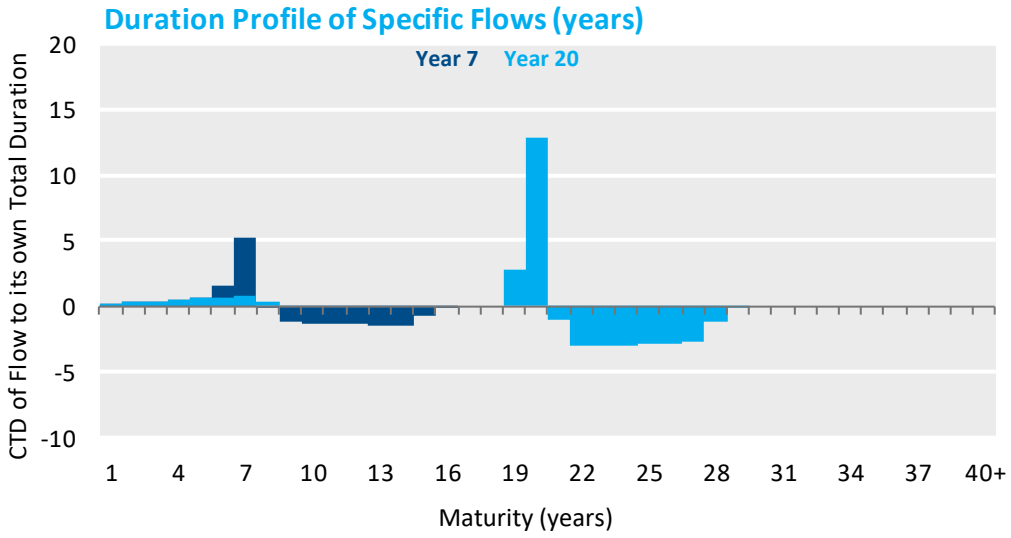
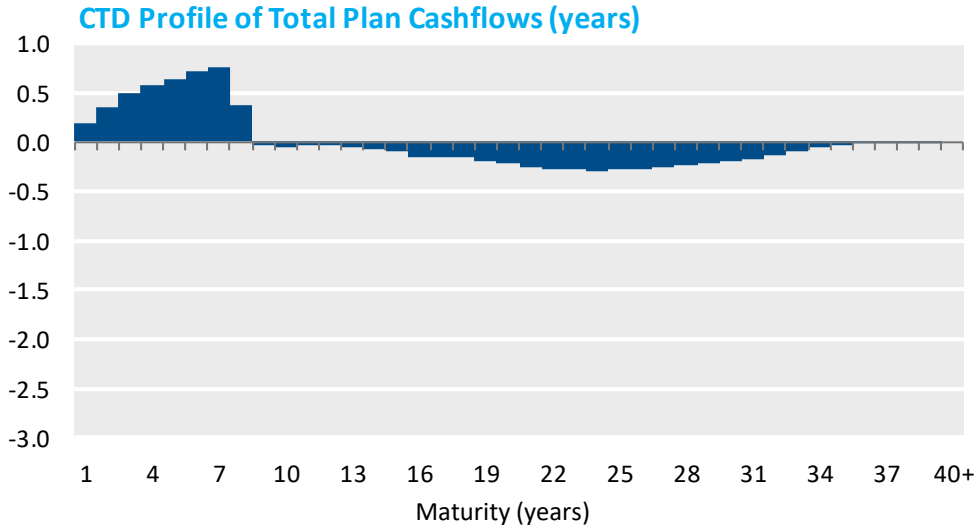
ICR Based on 8-year Yield





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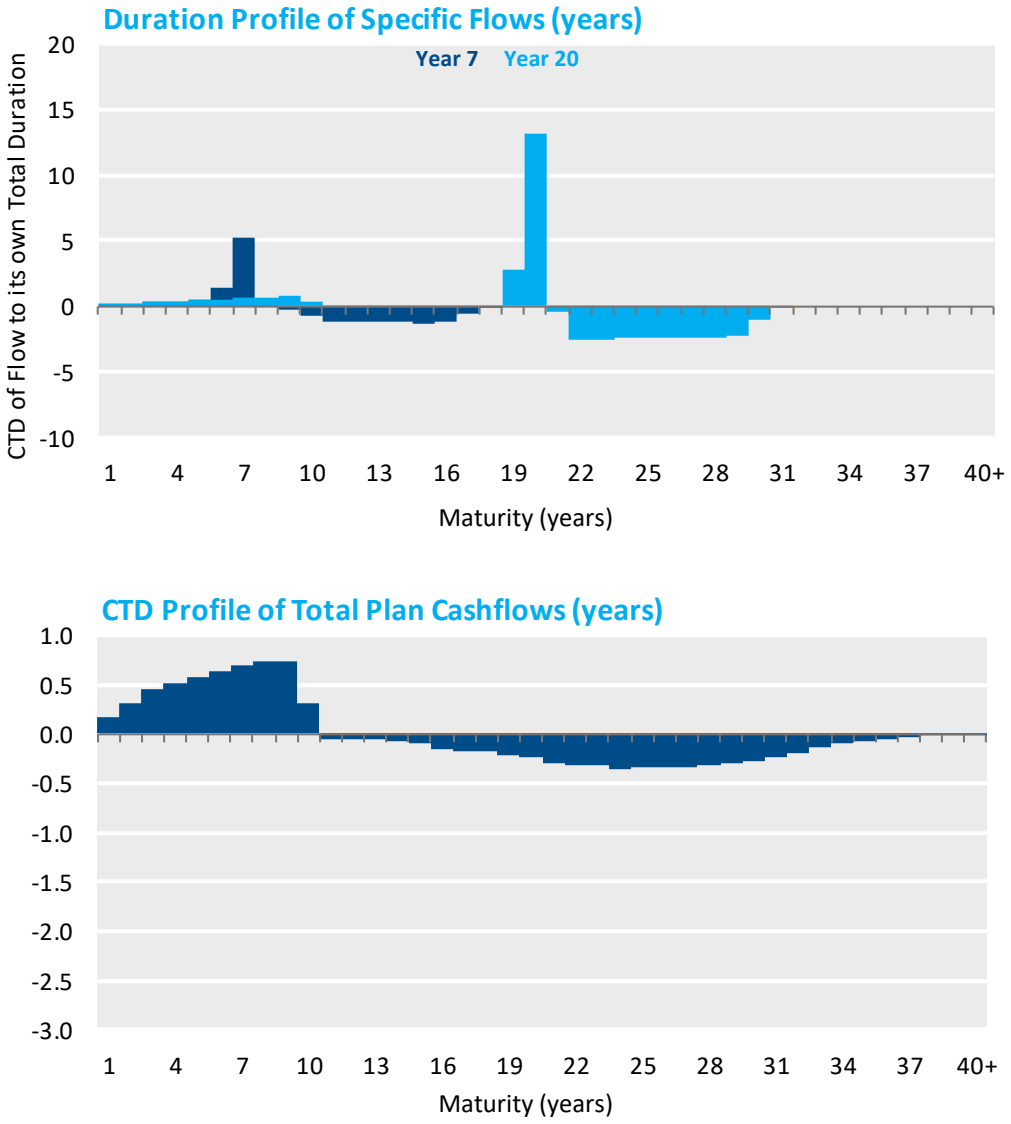
ICR Based on 10-year Yield



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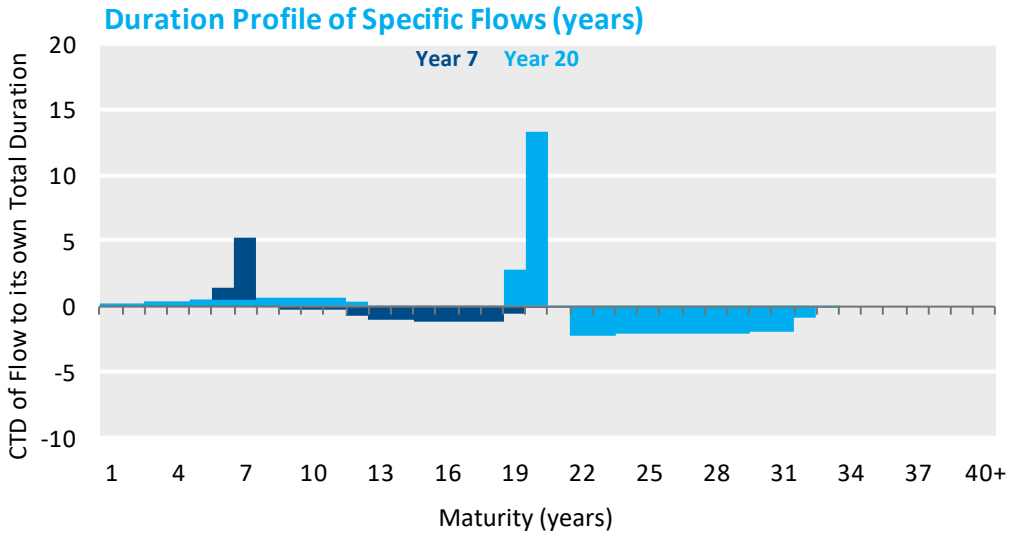
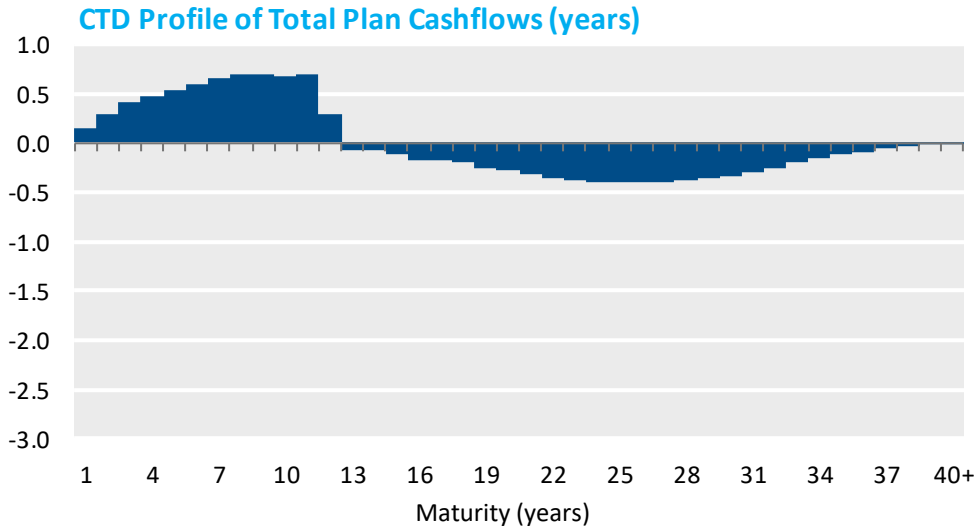
ICR Based on 12-year Yield





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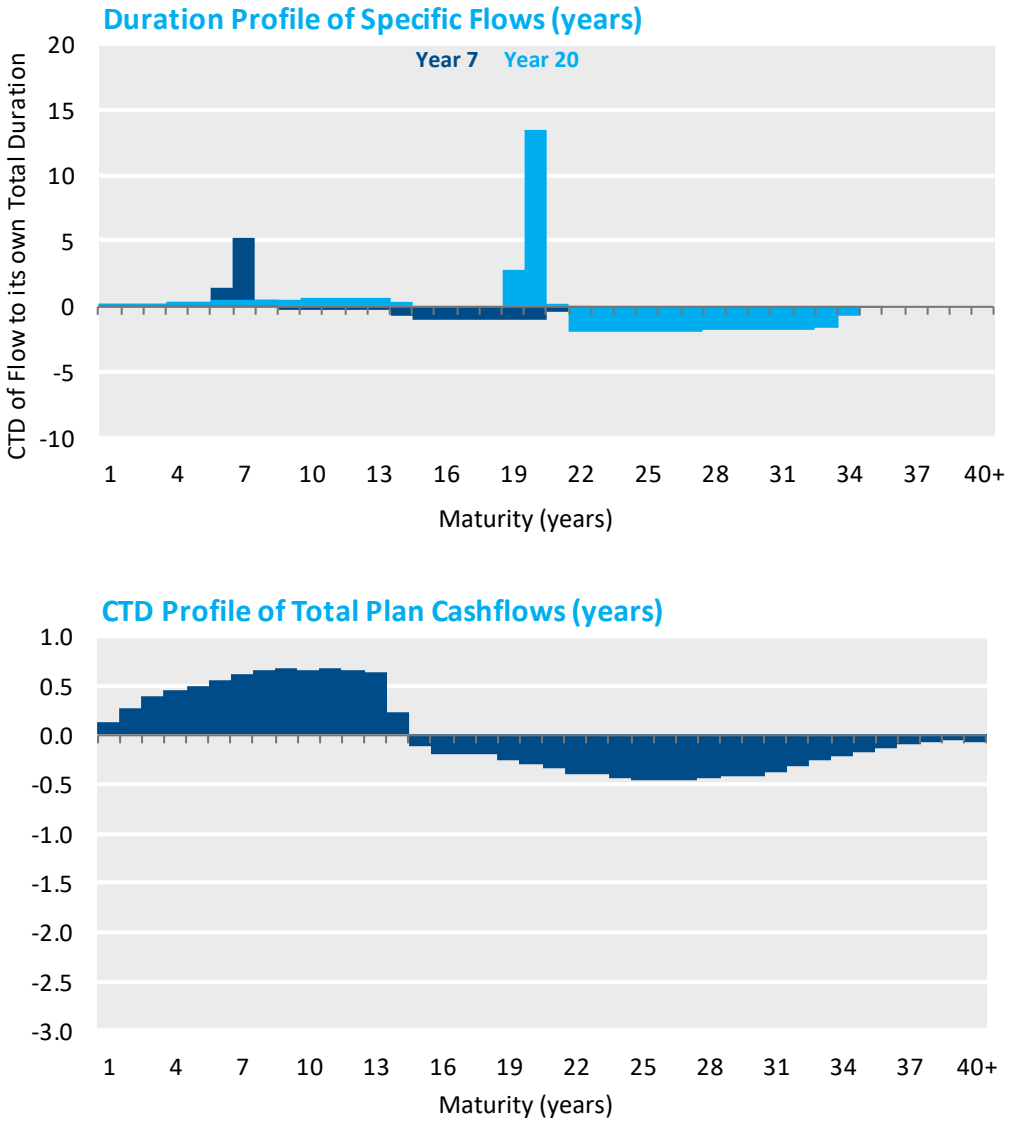
ICR Based on 14-year Yield



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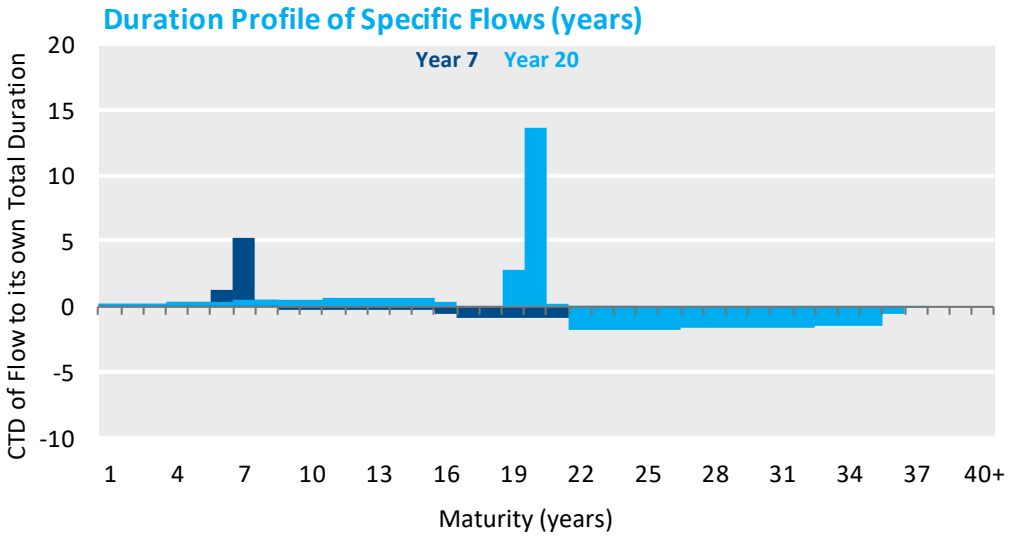
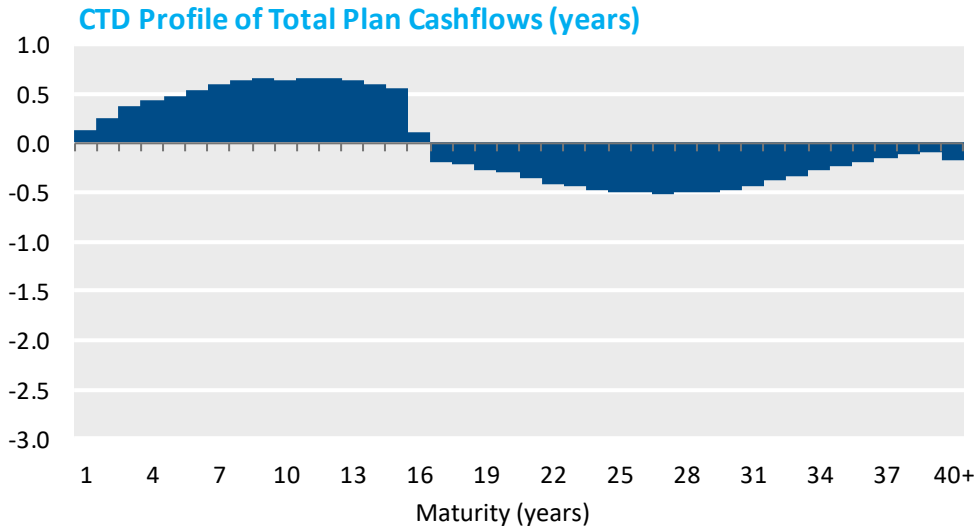
ICR Based on 16-year Yield





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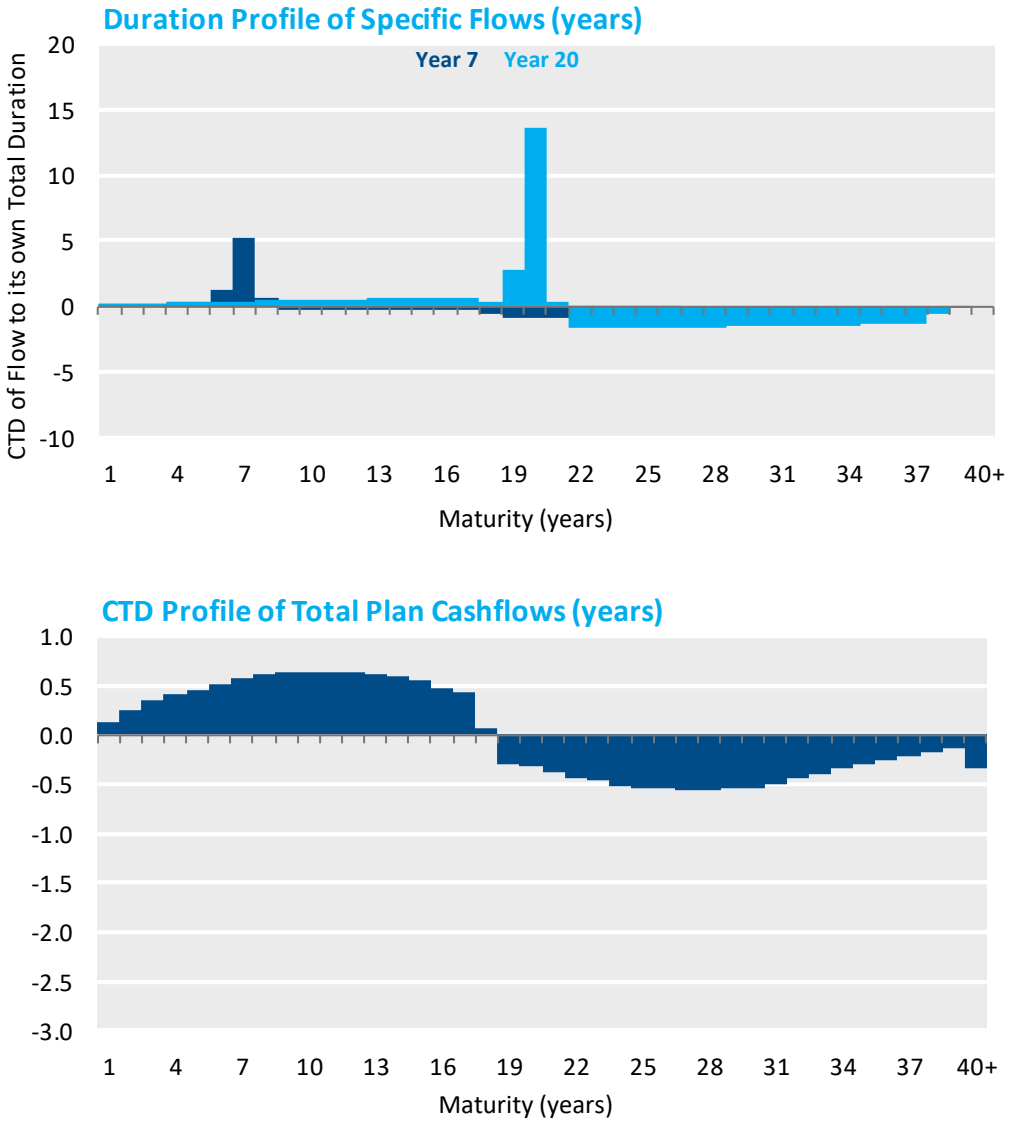
ICR Based on 18-year Yield



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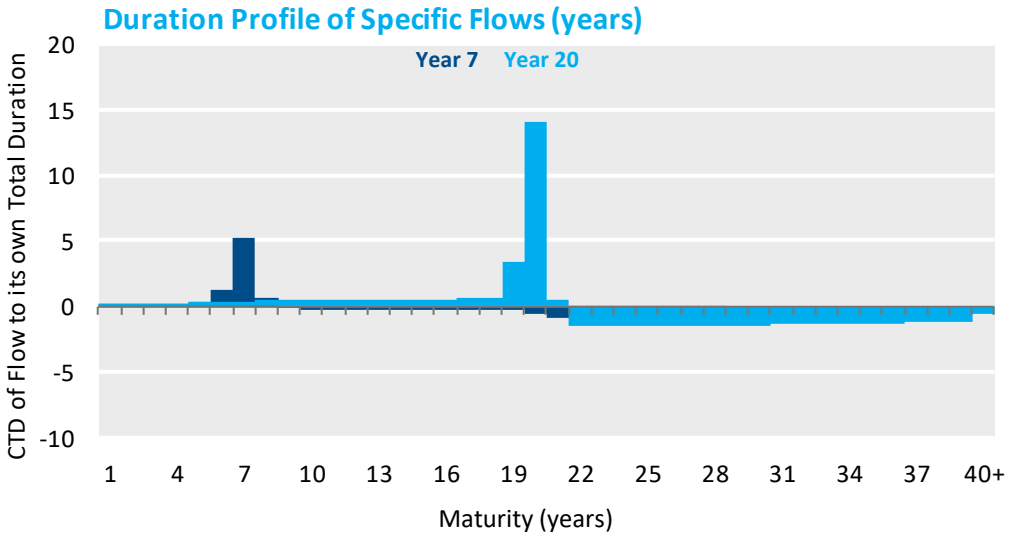
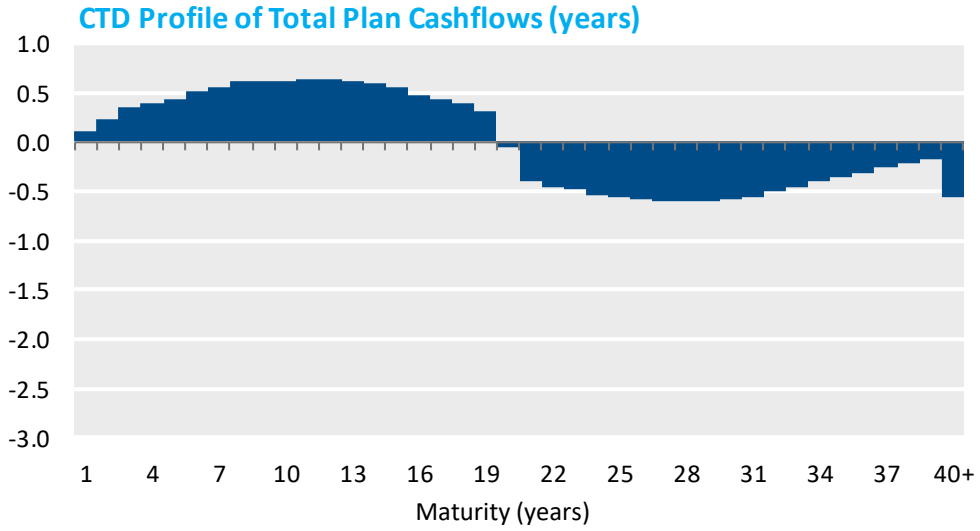
ICR Based on 20-year Yield





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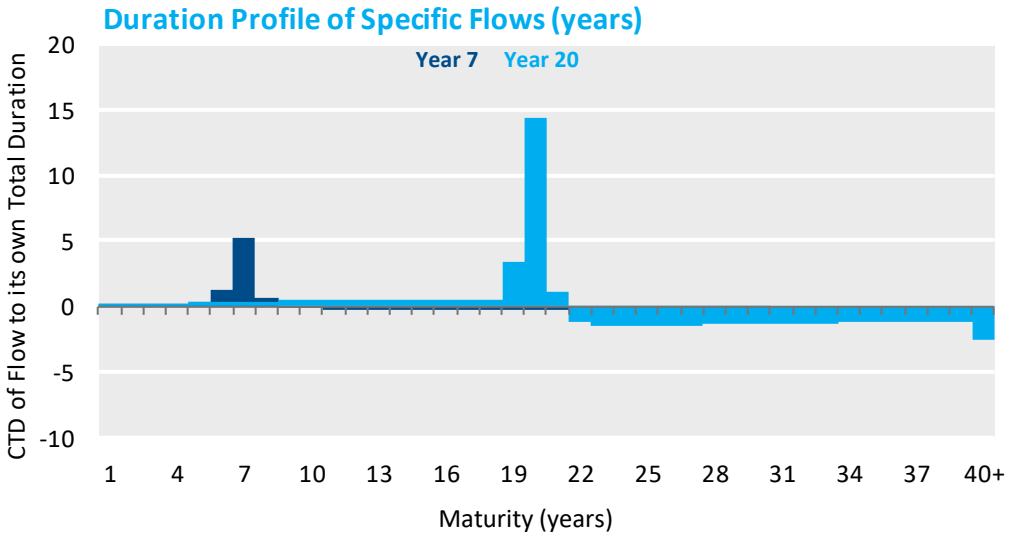
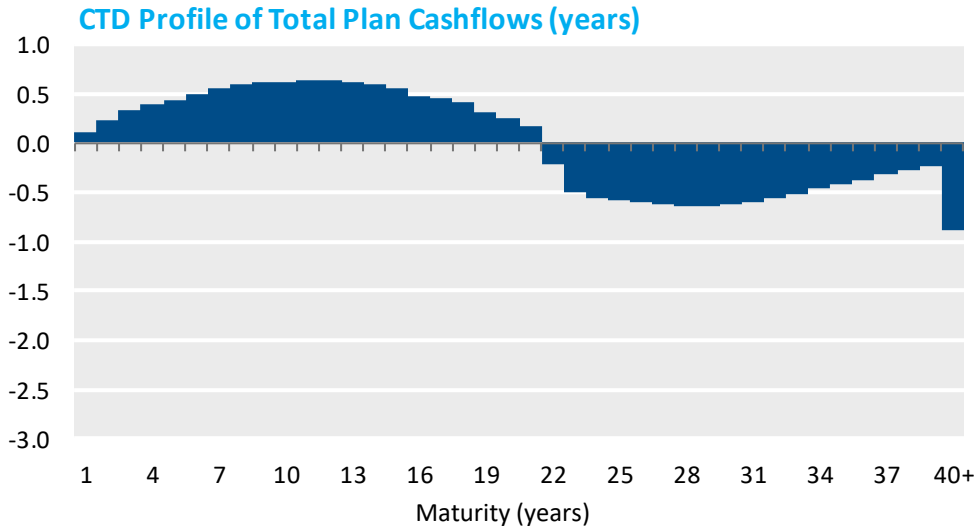
ICR Based on 22-year Yield





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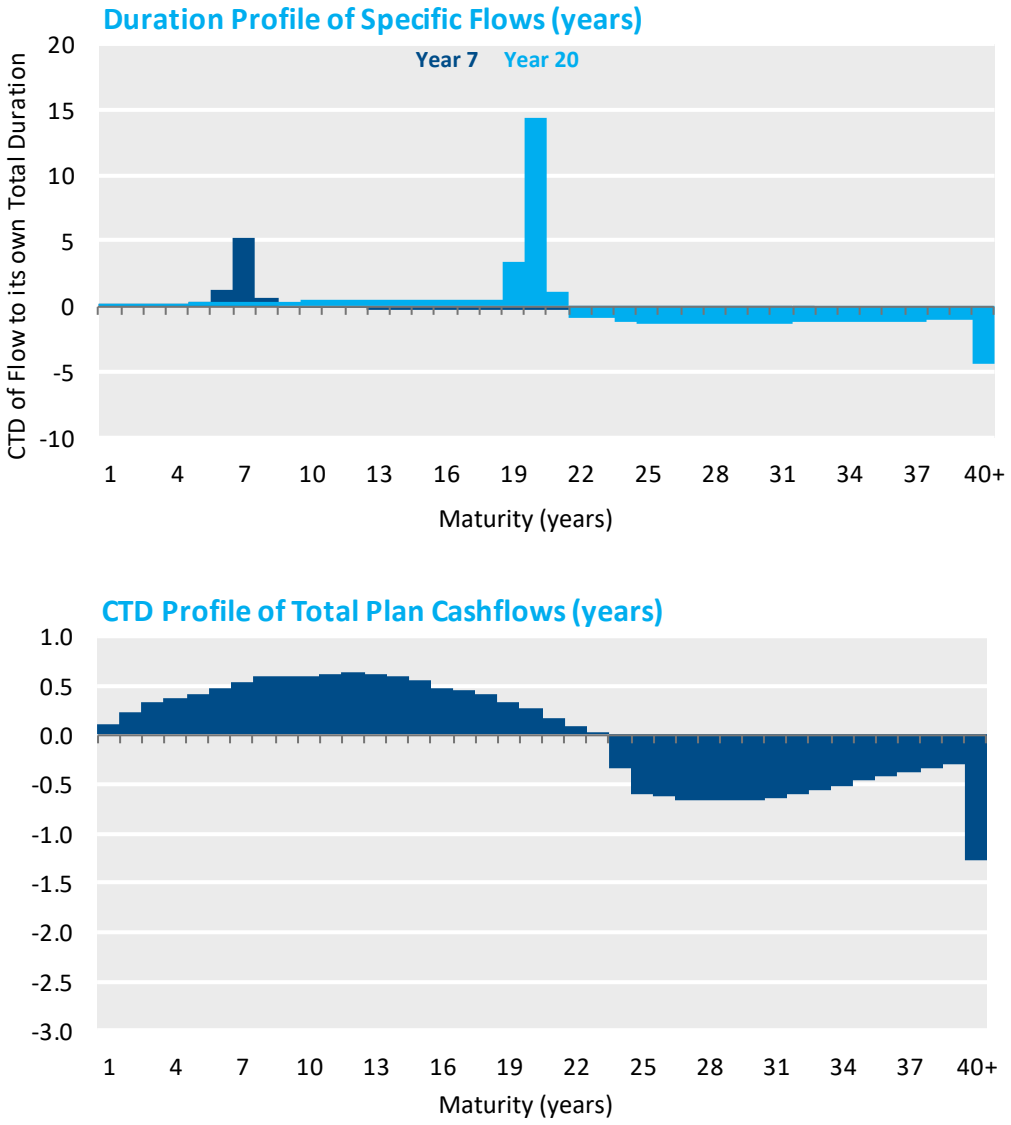
ICR Based on 24-year Yield



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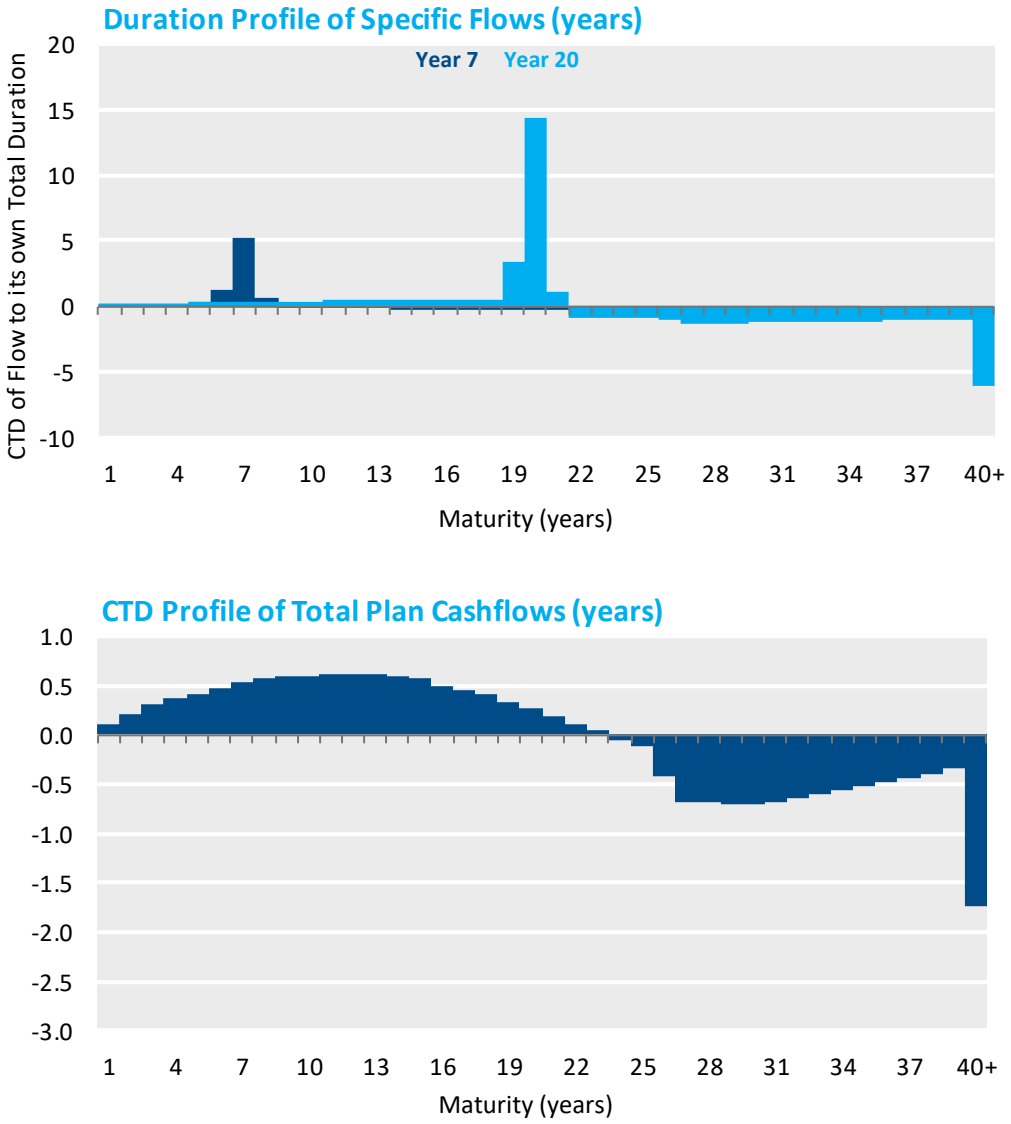
ICR Based on 26-year Yield



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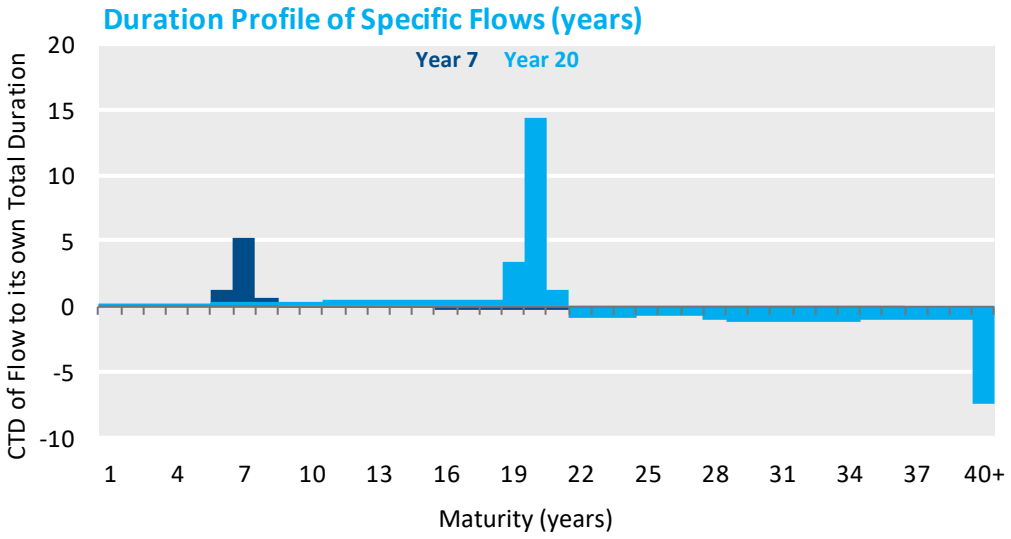
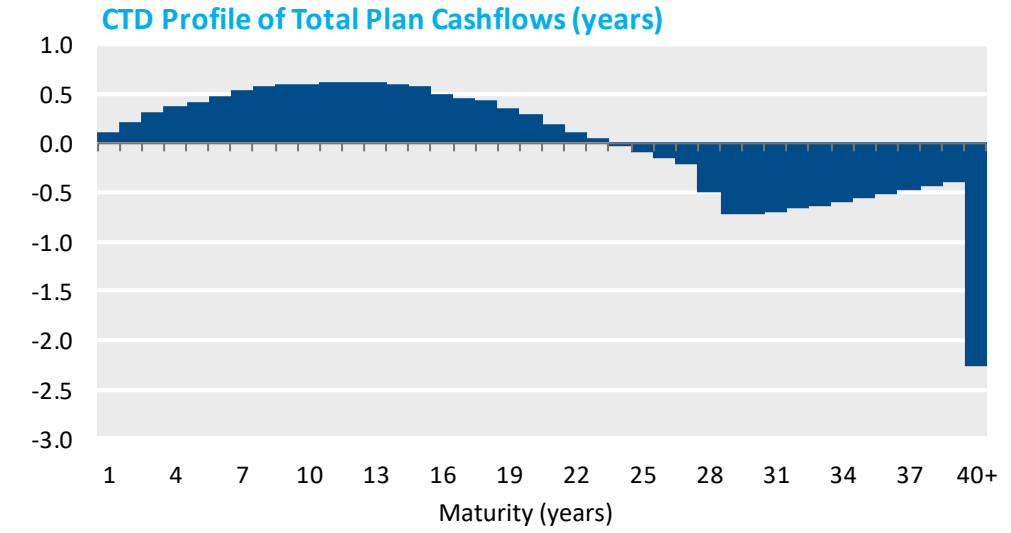
ICR Based on 28-year Yield





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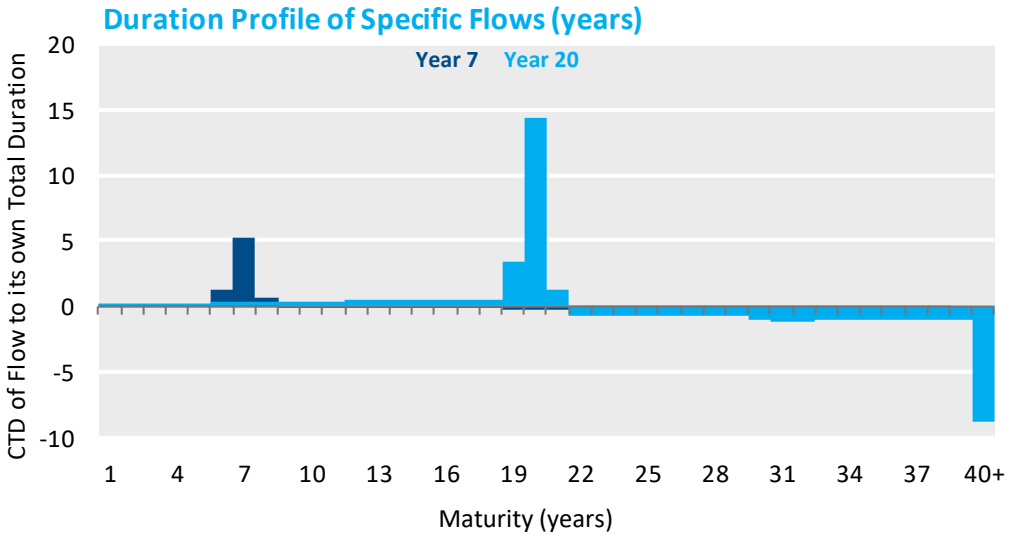
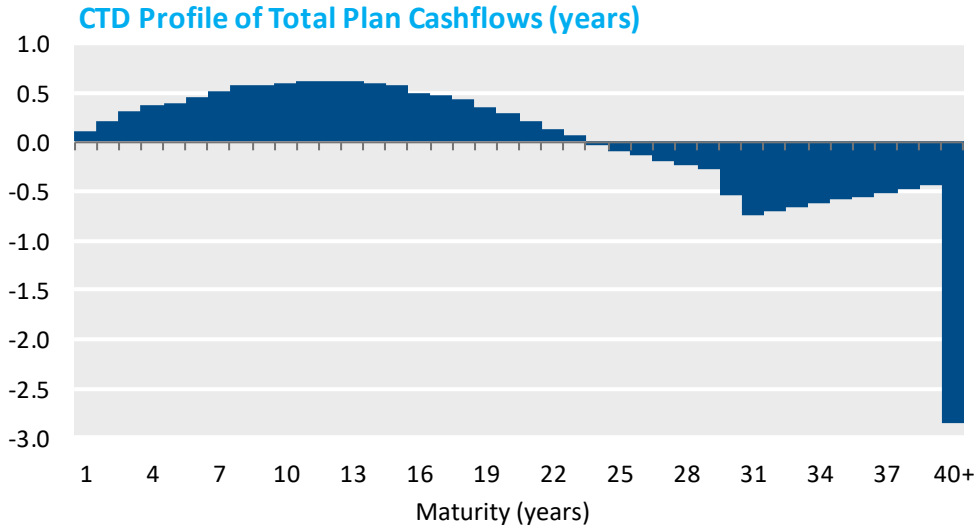
ICR Based on 30-year Yield





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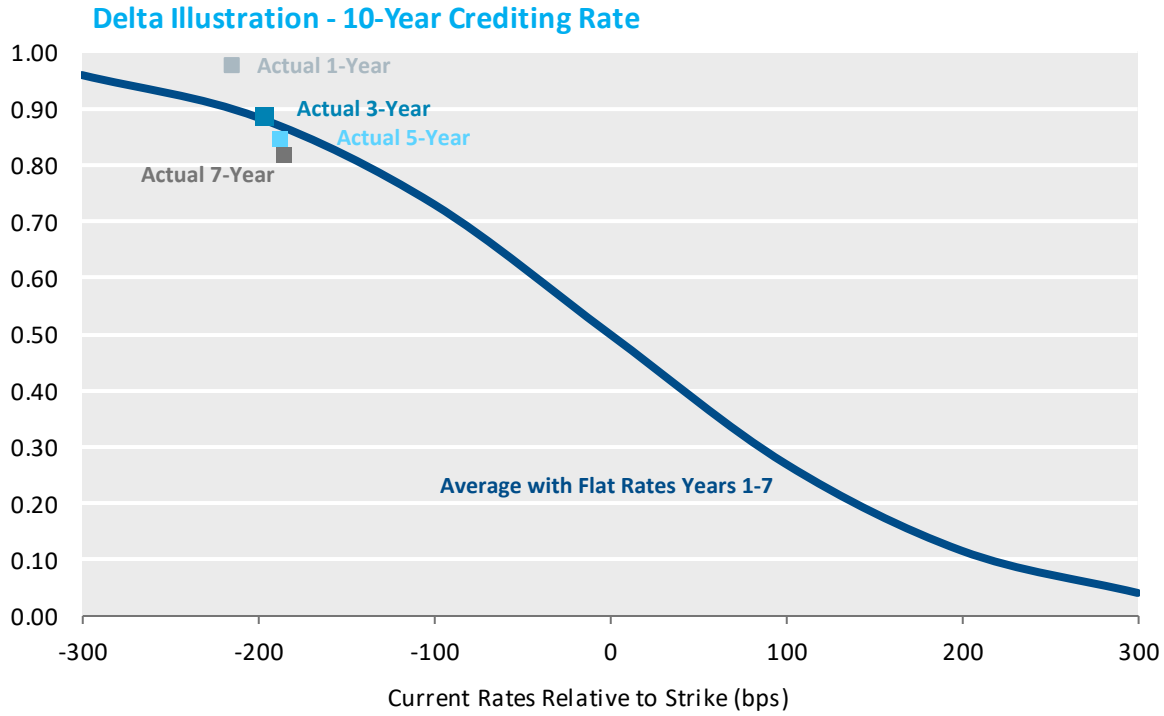
Effect of a Floor on a Cash Balance Plan

This illustration reflects the average delta of 7- and 20-year payments with a 4% floor and annual resets at all interest rate levels. It also shows sample individual tenors to show the impact of yield curve slope. Ultimately a plan reflects a combination of each projected payment stream.



- Delta is a function of prevailing market rates, volatilities, and the interest crediting floor.
- In reality, each future cash balance payment is compounded at the specified reset frequency.
- A plan with a floor may consider delta-adjusting its target interest rate hedge relative to the duration implied by the static cash flow profile.

Source: NISA Calculations. Charts are illustrative and based on a number of assumptions, including a flat term structure of interest rates and interest rate volatility estimated as of October 25, 2021. The estimated "delta" is a function of many inputs and assumptions. This illustration does not capture the compounding frequency. Additional information will be provided upon request.

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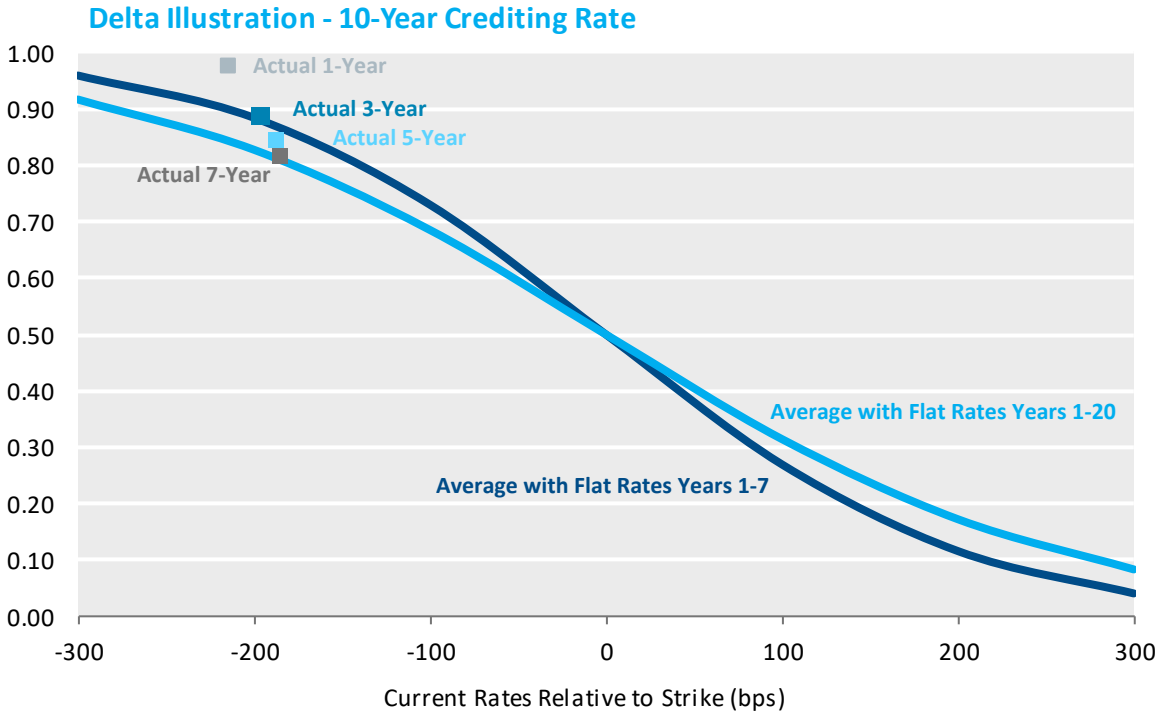

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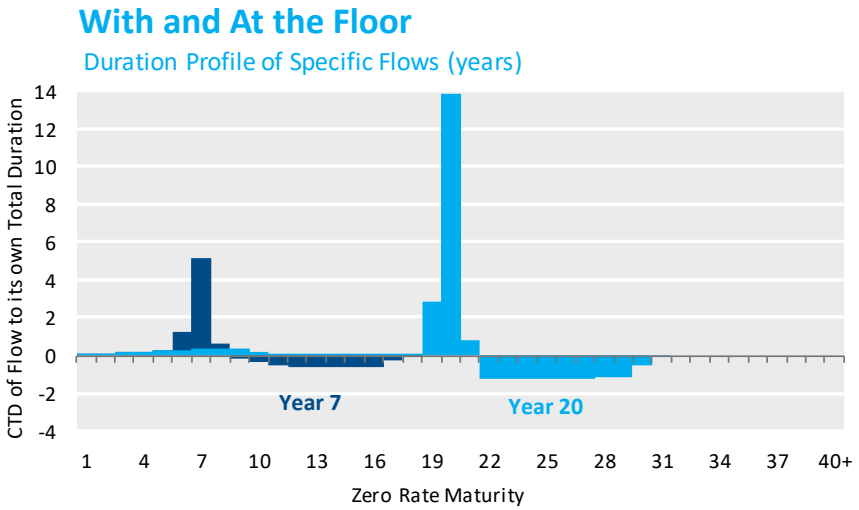
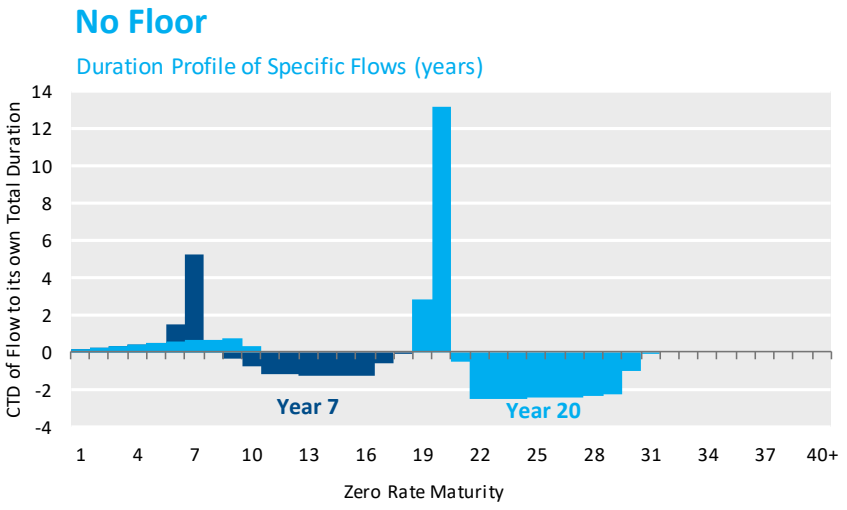
Yield Curve Exposure of a Cash Balance Plan

ICR Based on 10-year Yield, Rates = Flat 5%





Source: NISA Calculations. Illustrated based on a flat discount curve with no spread. Illustrative static cash flows are based on a duration of 10.4 years. Cash flows are assumed to be projected on a forward-implied basis bootstrapped from the underlying Treasury curve. CTDs (Contributions to Duration) are shown on a zero-duration basis.

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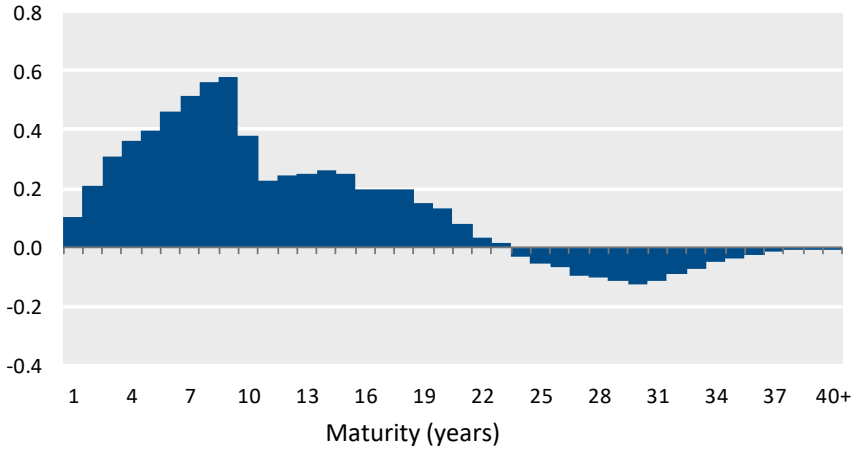
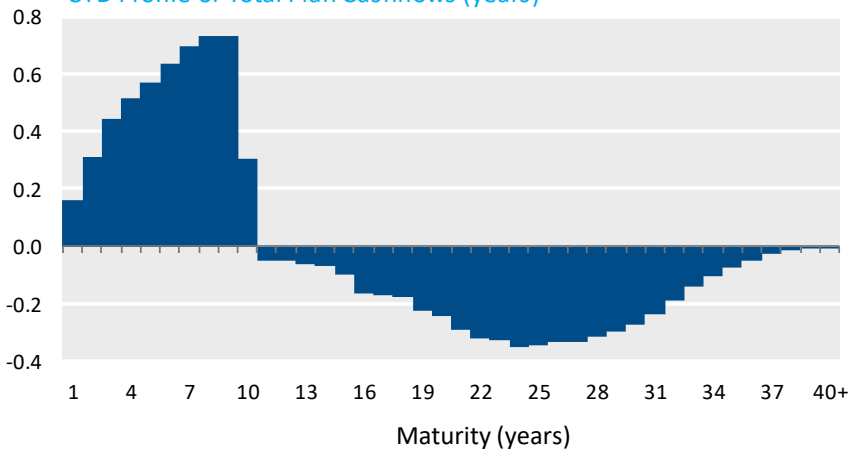
With and At the Floor

CTD Profile of Total Plan Cashflows (years)



No Floor

CTD Profile of Total Plan Cashflows (years)



Crediting Rate	"Delta" vs. Static	Total Duration (years)
Fixed (Static Cash Flows)	1.0	10.4
Floating (No Floor)	~0.0	~0.0
With and At the Floor	~0.5	~5.2

Source: NISA Calculations. Illustrated based on a flat discount curve with no spread. Illustrative static cash flows are based on a duration of 10.4 years. Cash flows are assumed to be projected on a forward-implied basis bootstrapped from the underlying Treasury curve. CTDs (Contributions to Duration) are shown on a zero-duration basis.

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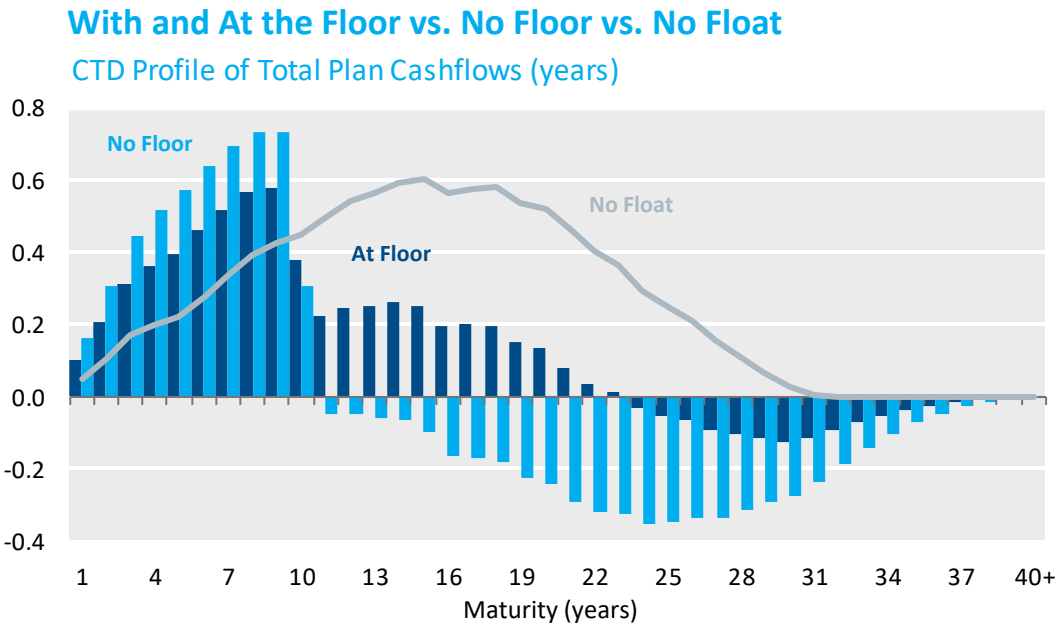


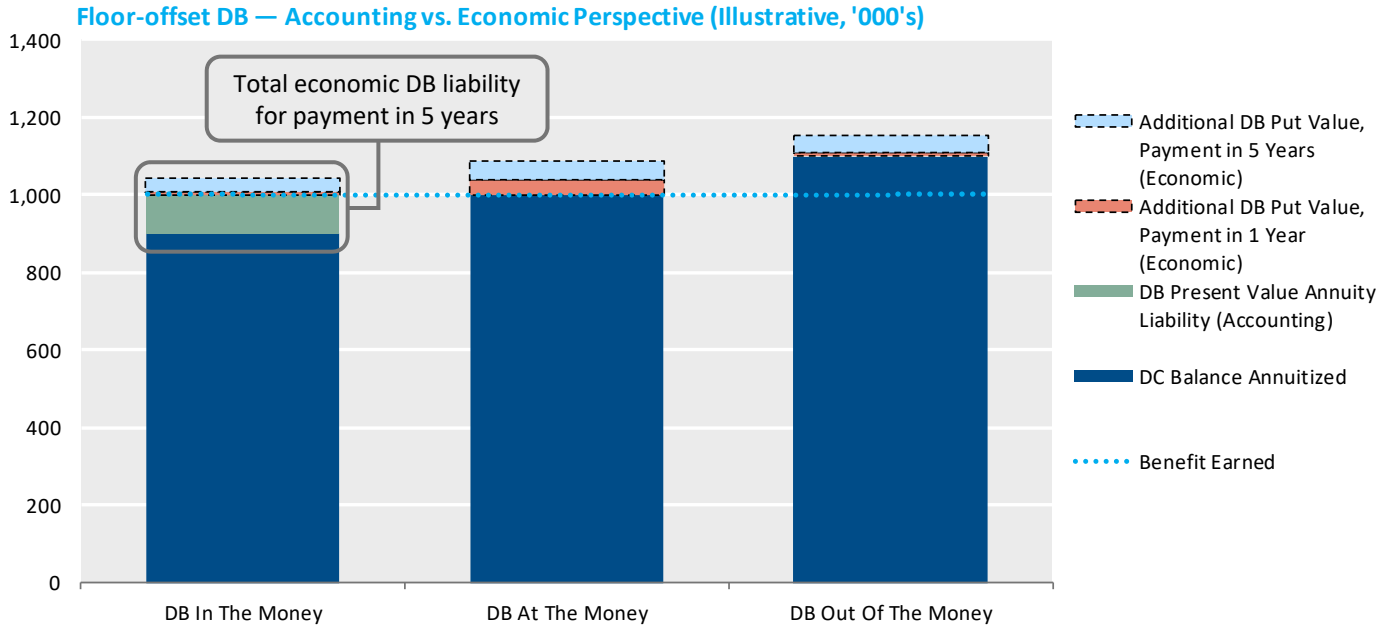
- Moving from well below the floor, to the floor, to well above the floor, we see the curve exposures shift:
  - **Well below the floor (or No Float):** CTD profile like a traditional plan
  - **Well above the floor (or No Floor):** CTD profile like a cash balance plan without a floor (exposed to steepener, ~0-year total duration)
  - **At the floor:** In between the above two states

Source: NISA Calculations. Illustrated based on a flat discount curve with no spread. Illustrative static cash flows are based on a duration of 10.4 years. Cash flows are assumed to be projected on a forward-implied basis bootstrapped from the underlying Treasury curve. CTDs (Contributions to Duration) are shown on a zero-duration basis.

Floor-offset Plans

Floor-offset Plans: Description and Economics

- Floor-offset plans combine defined benefit (DB) and defined contribution (DC) plans where the DB component serves to provide a "floor" on the total benefit. The DC is the "base" plan and the DB is the "floor" plan.
- To the extent the DC plan is unable to provide "floor" amount, the DB plan kicks in.
- For non-retirees, the **DB functions like a put on the DC**. The value is a function of:
  - Size of DC assets (moneyness of the option)
  - DC portfolio allocation (determines option volatility)
  - Participant benefit value and duration
- When DC can cover annuity payments, sponsors will report a zero DB liability on the accounting statement.
- However, the DB benefit likely has value and risk from both an accounting and an economic perspective.



Source: NISA Calculations. Illustrated for a benefit expected to be paid in 1 year and 5 years. DC balance is assumed to have 10% volatility. Any duration discrepancy between DC investment portfolio and annuitized DC Balance is ignored.

Floor-offset Plans: Interest Rate Exposure (Illustrative)

Interest Rate Exposure Considerations				
55-year-old Male Participant: 17.8 Year Duration Benefit, Present Value=$10,000				
	Scenario A	Scenario B	Scenario C	Scenario D
DB PBO Liability:	4,000	2,000	0	0
DB Assets Assumed:	4,000	2,000	1,000	1,000
DC Assets:	6,000	8,000	10,000	12,000
DC Funded Ratio:	60%	80%	100%	120%

	DB Duration (Years) Needed for 100% Rate Hedge			
DC Duration (years)	Scenario A	Scenario B	Scenario C	Scenario D
4	38	73	138	130
8	32	57	98	82
12	26	41	58	34

Gray shading indicates assumptions.

- Interest rate exposure needed in DB is a function of DC funded status, DC interest rate duration, and participant duration.
- The theoretical hedge for rates only would be to buy a call on a Treasury bond with the appropriate duration.
- A more practical approach may be to dynamically replicate the underlying options position.
- Because the DC likely has equity exposures, a portfolio option is the more direct hedge.

Source: NISA Calculations.

Other Plan Types

Pension Equity Plans

- Similar to cash balance plans, participants accrue a balance each year. However, the accruals are percentage points to be multiplied against a final earnings amount.
- Portability — participants can more easily access and roll over benefit when they leave their employer.
- While annuity form of benefits are available, the participant, **NOT** the plan sponsor, is at risk to the conversion rate.
- Generally lump sum cashflows should be used for hedging purposes.

Market-Based Cash Balance and Variable Plans

- Market-based Cash Balance Plan
  - Crediting rates are based on investable market returns (e.g., returns on index funds)
  - Can be structured to not capture full market return
  - Must have a positive return over lifetime
- Variable Annuity – benefits change after they are earned, often based on a funded status calculated using a hurdle rate or based on actual returns
- Variable Accrual – benefit accruals are a function of funded status at accrual

Conclusion: These plans require a different structure than traditional LDI programs. However, the risks are very hedgeable.

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