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Consultants and Actuaries

Section AFIR/ ERM

Pension accounting forecasts based on nested stochastic modelling

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- Actuarial and Pension Fund Consulting
- International Accounting
- Pension Fund Administration
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Agenda

Pension Accounting Forecast

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Objectives of this study

International Pension Accounting

Important key metrics in International Pension Accounting (IFRS, IPSAS & US GAAP)

Important key metrics

For forecasting IFRS/ US GAAP/ IPSAS results

■ **Discount Rate**

- The level of discount rate and its potential future development has the most substantial impact on Defined Benefit Liabilities (DBO) and on the Gross Service Cost (GSC) of coming financial year

■ **Portfolio return**

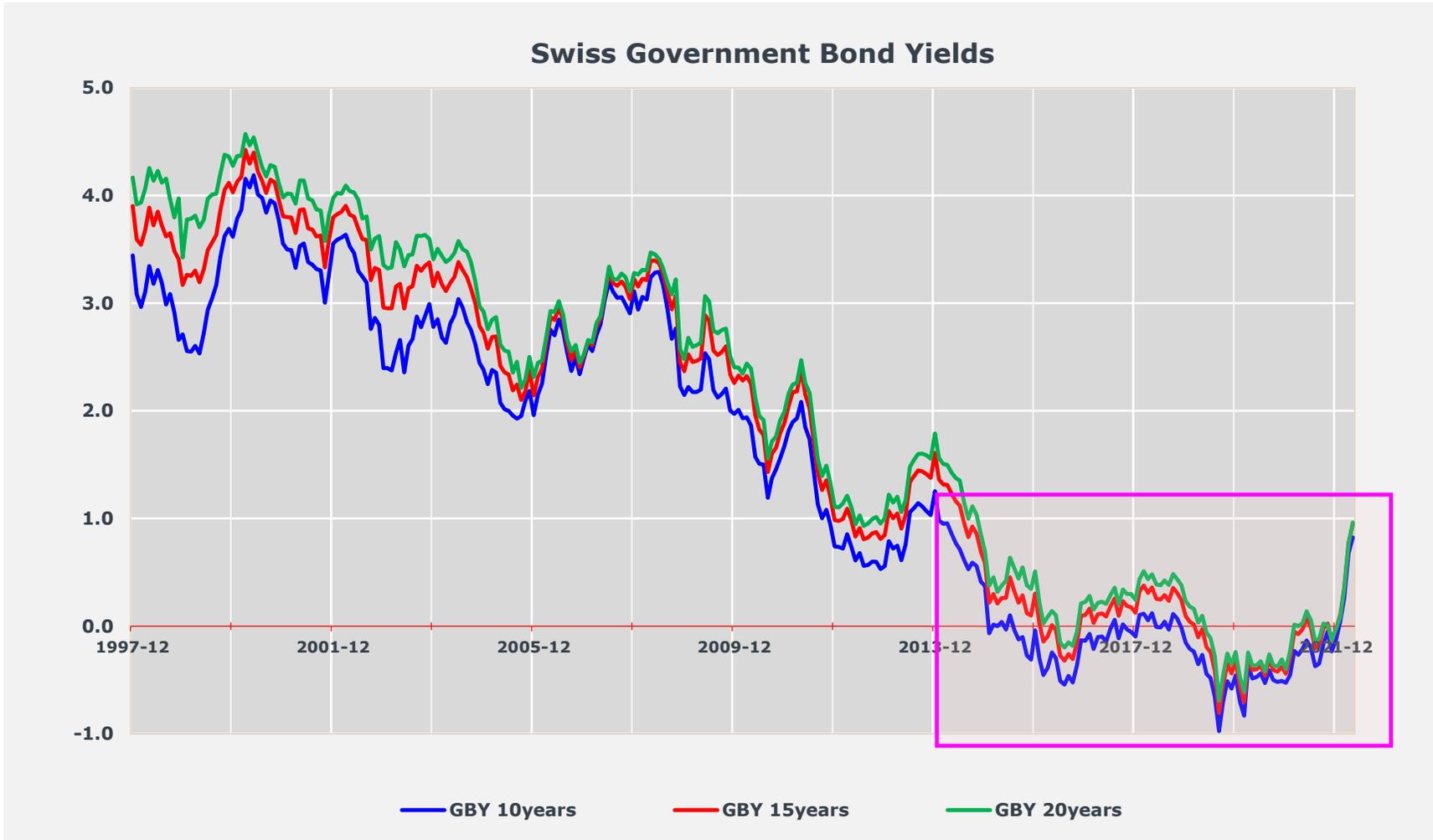
- In IAS19 valuation it has a strong impact on the Net-Liability (= DBO – Plan Assets) in a pension fund
- Additionally in Switzerland the high level of portfolio return could help increase the interest credits for saving accounts and it will have an additional impact on the DBO (but much lower compared to the discount rate impact)

■ **Mutations of the pension fund membership**

- The development of the active membership and pensioners population which does not correspond to their expected development has an impact on the OCI position
- Stochastic forecasting of membership development helps to evaluate it

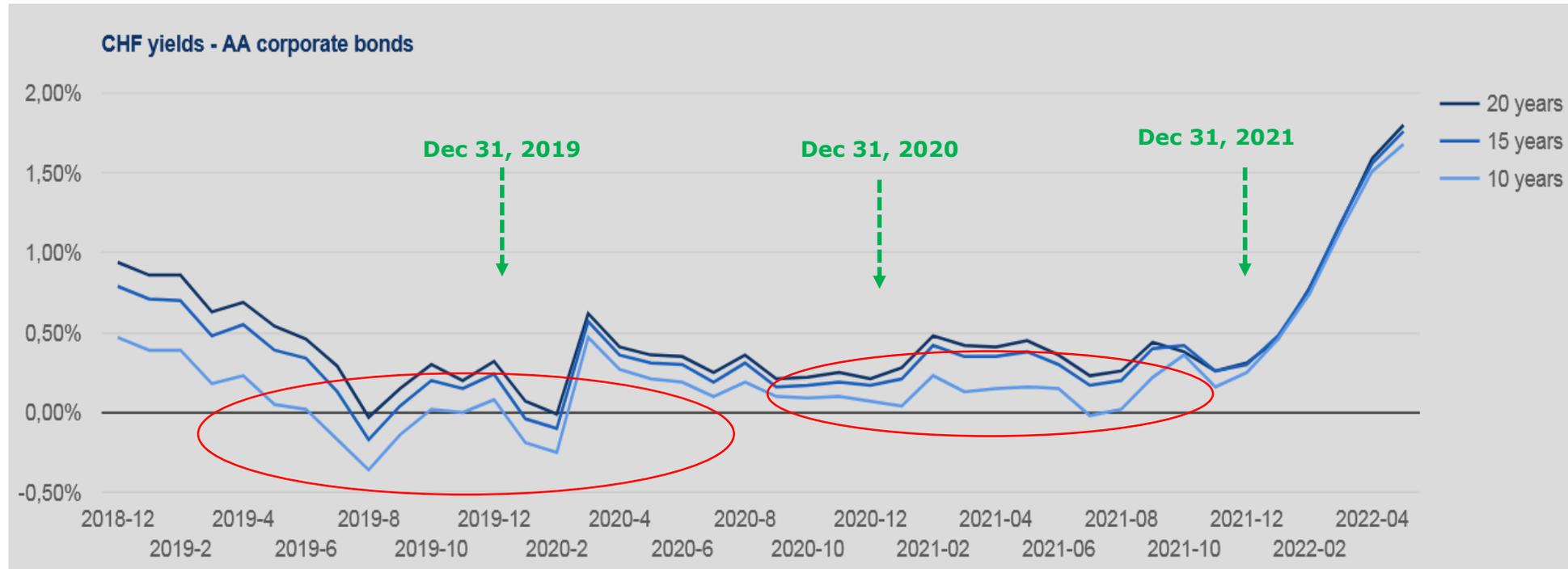
Swiss Government bond yields (IPSAS Discount rates)

AA Corporate bond yields (IFRS & US GAAP) are affected as well



IFRS: Swiss discount rates used since Dec 2018

CHF Yields - AA Corporate Bonds (prepared allea Ltd.)



- As a rule: durations of Swiss pension fund liabilities in international accounting (IFRS & US GAAP) are between 10 and 20 years (Jubilee plans have much smaller duration but their impact is very small as well compared to the pension plans)
- Historical yield values with durations 10, 15 and 20 years – as discount rates

Forecast of International Accounting Results

Which parameters important for such forecasting

■ **Discount Rate**

- For the forecasting of the discount rate it is necessary to prepare forecasting of the yield curve and determine the discount rate based on the liability duration
- The liability duration depends on the level of discount rate, on the structure of the pension fund membership, their benefits as well as some assumptions like pension indexation and interest credits

■ **Portfolio return**

- Stochastic forecasting

■ **Development of benefits and liabilities based on plan rules**

- Monte Carlo Simulations of pension fund active membership and pensioners help to value the bandwidth of the future liability development
- Historical analysis of the pension fund membership structure over the last years will help to set up assumptions for the potential future membership development

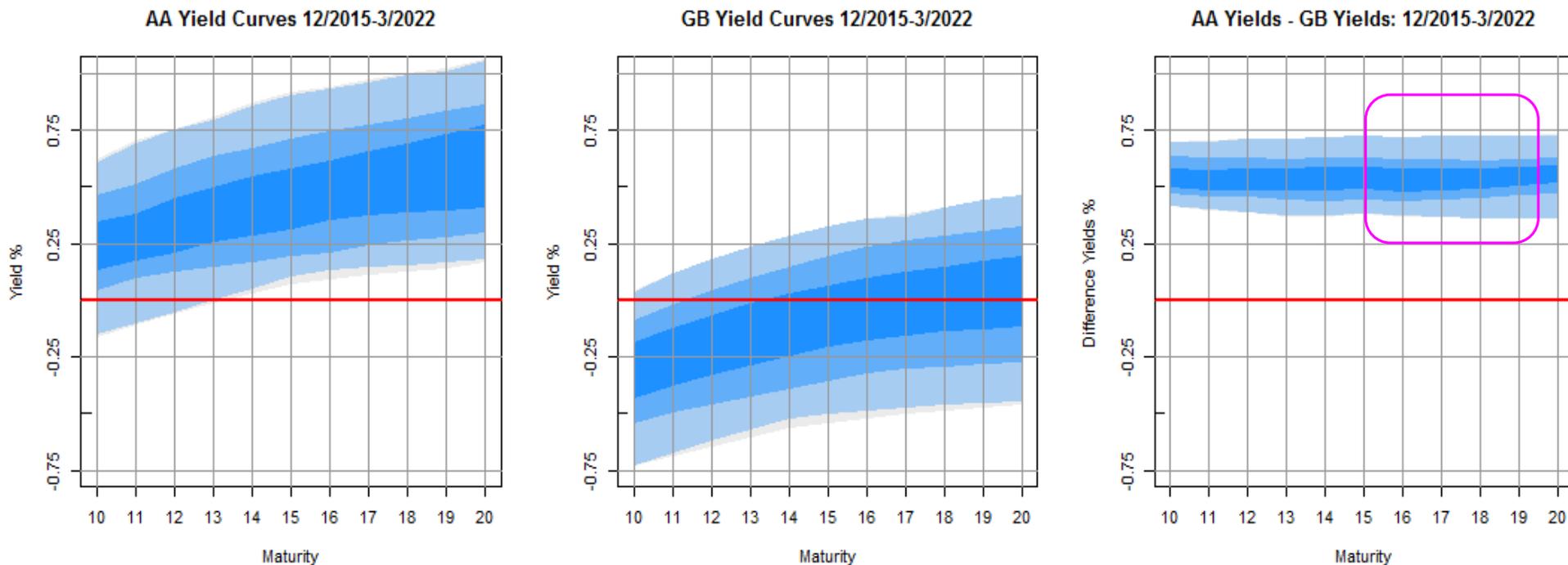
Approach & Results

Approach for yield curve forecasting

Neural Network Autoregression (NNAR)

IFRS: Swiss discount rates used since Dec. 2015 – March 2022

CHF AA Yields Curves vs. CHF GB^{*)} Yield Curves

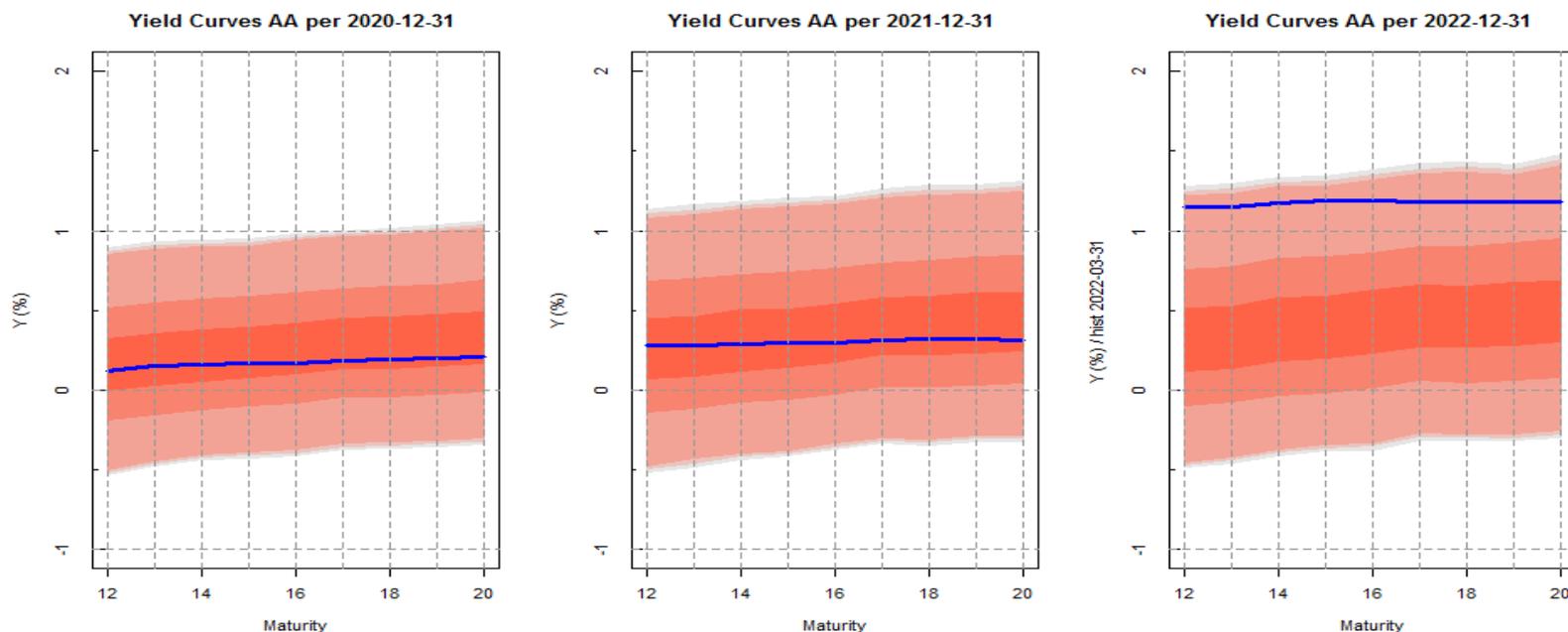


- AA Corporate Bonds Yield Curves vs. GB Yield Curves
 - CHF AA Yield Curves are practically parallel to CHF GB Yield Curves (over Dec 2015-March 2022)
- The typical liability duration is in the bandwidth: 16-19 maturity years
- Colour intensity: confidence interval 30%, 60% and 90%

^{*)} GB – Government Bonds, CHF – Swiss Franc
CH – Confoederatio Helvetica

Forecast AA Yield Curves per Dec 31, 2019

Historical data (**blue curves**) per Dec 31, 2020, Dec 31, 2021 and March 31, 2022



Comparison of forecasted AA Yield Curves (NNAR) with their historical values

- The AA Yield Curves per Dec 31, 2020 and per Dec 31, 2021 are a bit flatter compared to the forecasted ones – but within the bandwidth 30% (between 35% and 65% percentiles)
- The AA Yield Curve per March 31, 2022 increased in Feb-March 2022 due to the string increase of the Government Bonds Yield Curve

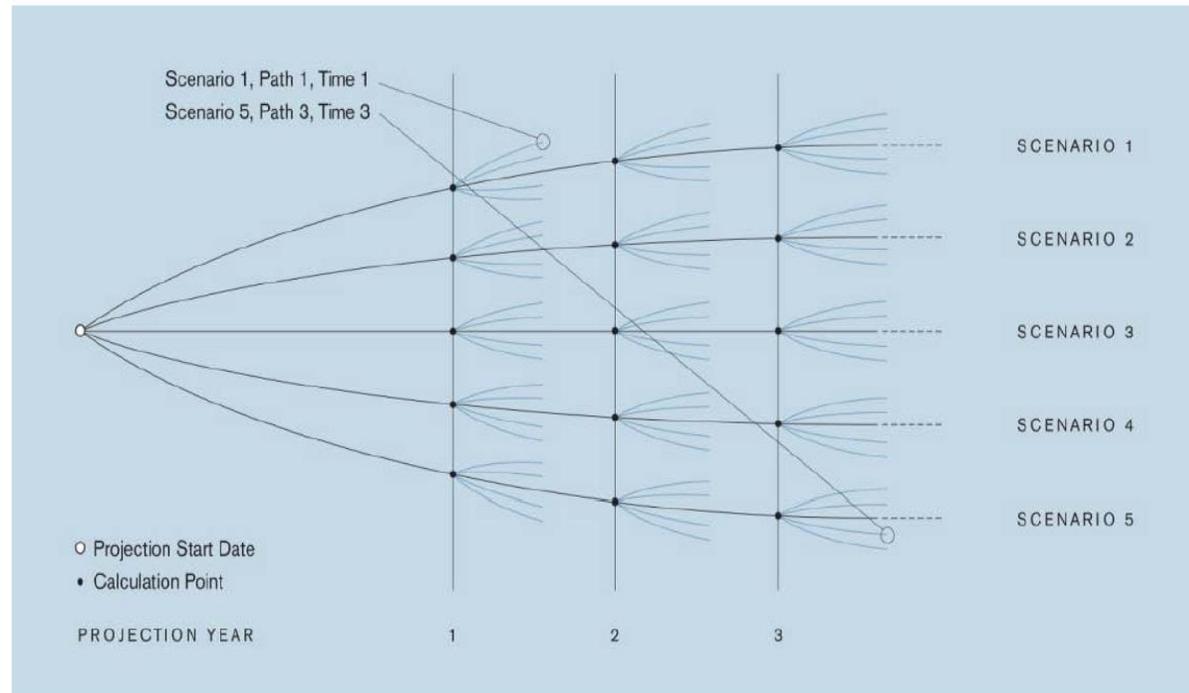
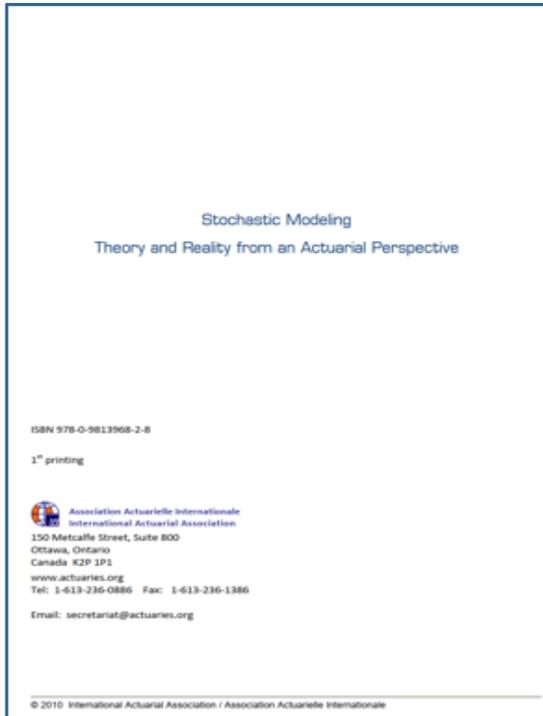
Approach for liability modelling

Nested Stochastic Projections

Liability Stochastic Simulations

Based on Nested Stochastic Projections

- Very Useful Book



Excerpted from "The Future of Capital Modeling," by Pat Renzi, Milliman Insight, Issue 2, 2006.

- Book „Stochastic Modeling: Theory and Reality from an Actuarial Perspective“, ISBN 978-0-9813968-2-8, www.actuaries.org (Milliman)

Impact Fund Membership and its Development

Active membership vs. Pensioners

- Modelling of active membership
 - Stochastic simulations of leavers, death and disability cases, retirement and new enters
 - Formally the impact of a stable, growing and decreasing membership population should be investigated – **here (in this example) the pension fund active membership is growing**
- Modelling of pensioner population
 - The pensioner population is „open“ because every year new potential retirees, spouses and disabled persons could enter into the pensioner population – but it is not open for the extract pensioners
 - Only in case of death all kind of pensioners will quit from the pensioner population
 - Disability pension (in Switzerland) is paid up to the retirement age and after the retirement age the disabled person will be „converted“ into the retiree state
- Child pensions (orphan, child pension for disabled and child pension for retiree if child younger than 25) will be (here) modelled as a capital payment
 - The impact of these benefits is small

Pension Fund Membership

Cash Balance Plan for active membership

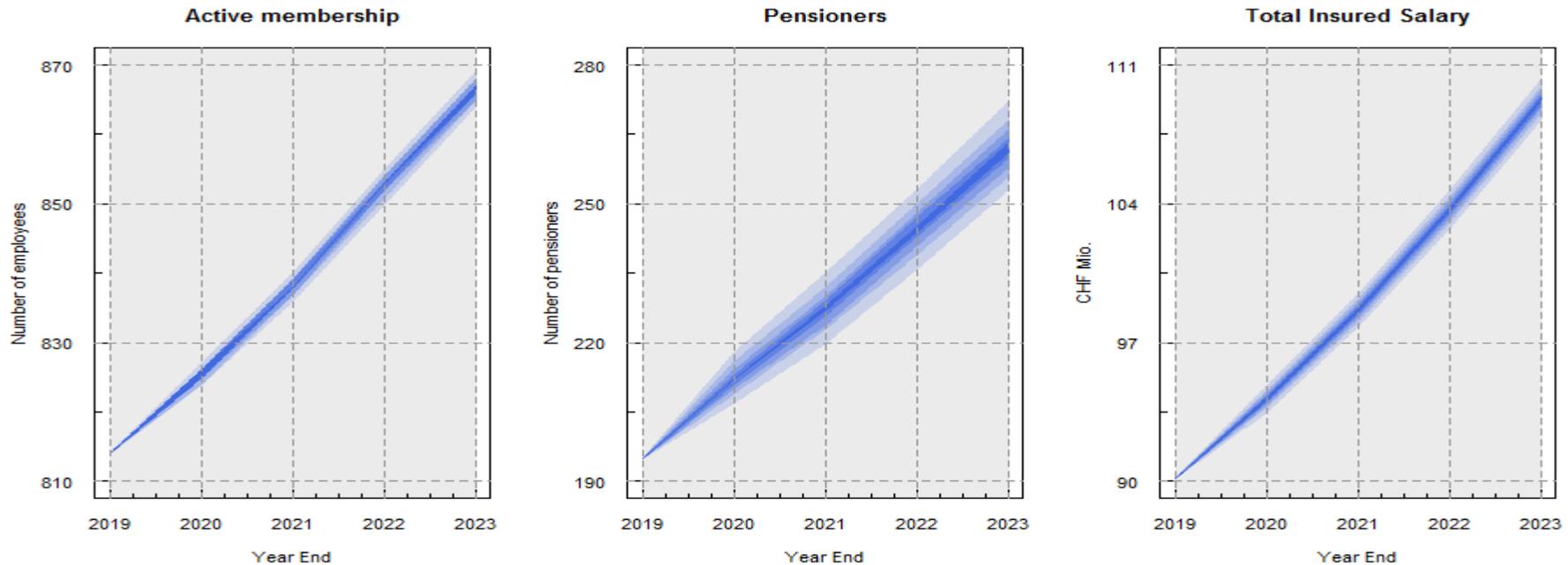
Information per December 31, 2019	Number	Average age	Liabilities *) (local accounting) CHF Mio.	Average insured salary and Average pensions (in CHF)
Active membership	814	44.3	332.4	110'750
Pensioners	195	69.1	217.9	52'780

*) Local liabilities for:

- active membership – vested benefits (i.e. individual saving accounts);
- for pensioners – the DBO pensions in payment with the local discount rate
 - The local discount rate has an upper limit based on the Guidelines FRP4 (now 2.17%) which depends on the average level of the 10-year government bond yield over the last 12 months per September 30, 20XX (plus 2.5%)
- Open autonomous pension fund with active membership and pensioners
- The size of this pension fund is middle compared to other Swiss pension funds
- The retirement age is 65 for males and 64 for females

Example: Nested stochastic Liability Forecasting

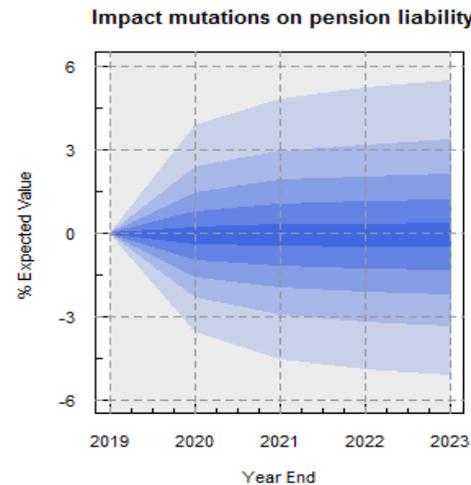
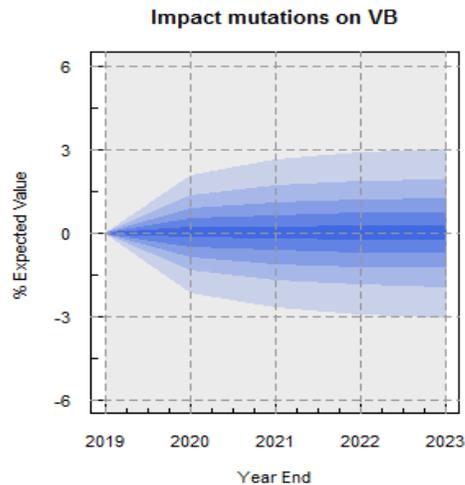
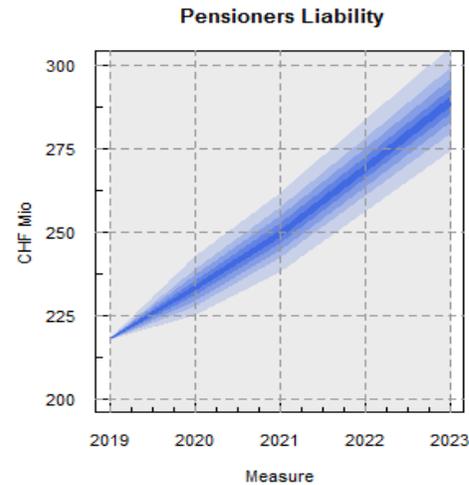
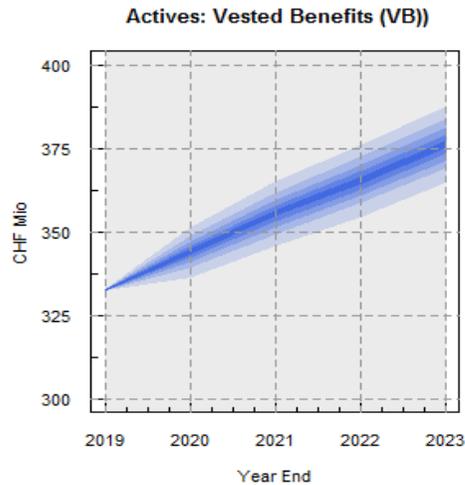
Forecast over the next four years: Starting per Dec 31, 2019



- Per Dec 31, 2019
 - Number of employees 814
 - Number of pensioners 195
- On average over 2019-2023:
 - Number of employees increases by ca. 1.6% per year
 - Number of pensioners increases by ca. 7.5% per year (only for membership and not outside)
 - The sum of insured salary increases by ca. 4.9% per year (due to employee increase as well)
- Membership mutation implemented here – only death/ disability/ retirement/ new entries & leavers

Development Liabilities: based on the local plan rules

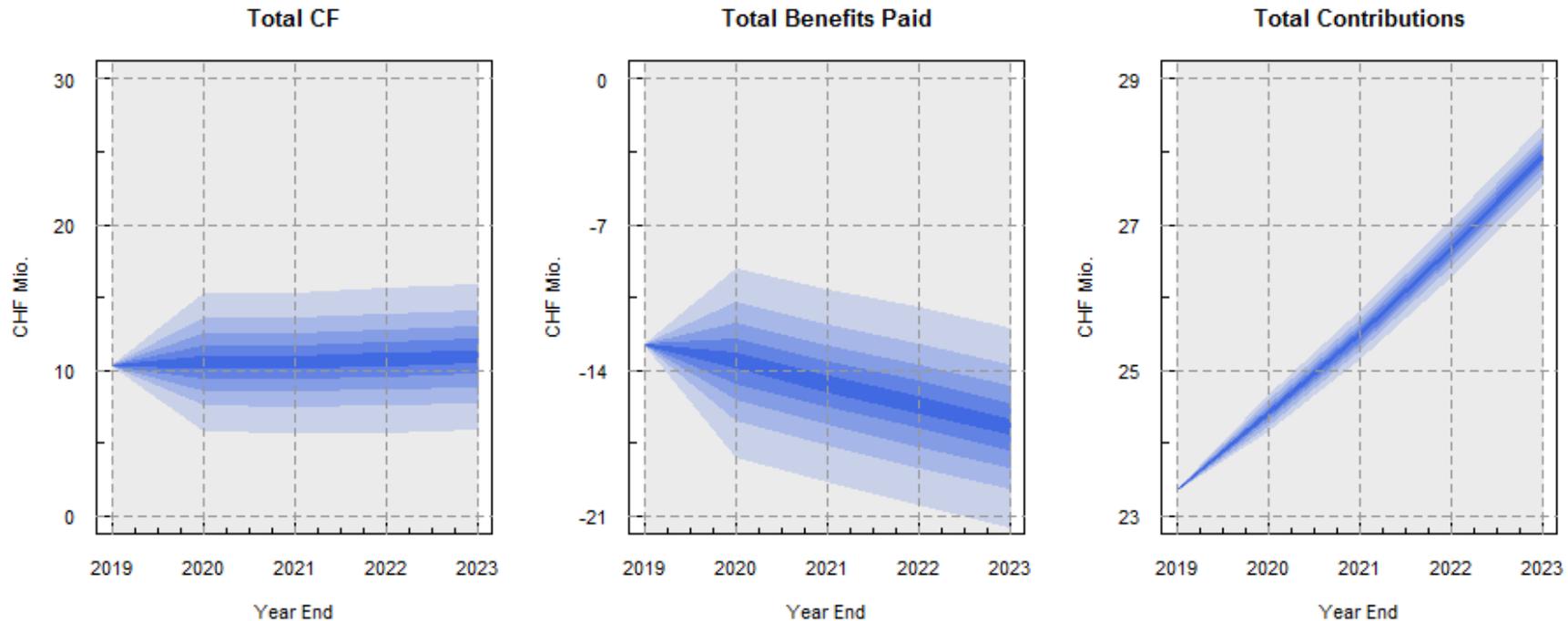
The impact of pension fund membership mutations on local liabilities



- The vested benefits active membership correspond to the individual saving account
 - The level of this account has an impact on the future retirement pension level and on the DBO
- Pensioners liability is a DBO valued with the local technical interest rate (here 1.5%) instead of the discount rate in IAS19 (here start value 0.28% per Dec 31, 2019)
 - The lower the membership number the stronger the impact of the membership mutations
- By this simulation
 - The local technical interest rate is 1.5% and constant over 2019-2023
 - The interest credit is 1% and constant over 2019-2023
- The total bandwidth is 90% (between 5- and 95- percentiles) and step 10%

Cash Flow (CF), Benefits & Contributions (start per Dec 31, 2019)

Potential development over next years 2019-2023



- The total cash flow (CF), total benefits paid and contributions have an impact on the P&L and OCI positions
- The total bandwidth is 90% (between 5- and 95- percentiles) and step 10%

Forecast IAS19 Positions for pension fund

Nested Stochastic Projections

Assumptions per December 31, 2019

IAS19 Disclosure

Parameters	Assumptions for IAS19 Disclosure
Discount rate	0.28% per December 31, 2019 (Duration 17.4 years)
Interest Credits for vested benefits	Max(Mandatory Interest Credit, Discount Rate) Mandatory Interest Credit = 1% * Mandatory saving capital Mandatory saving capital is 25% of the total vested benefits (Pension Fund specific). The current level of mandatory interest credit for the mandatory saving capital is 1% (could be adjusted for every year and is valid for a year)
Salary increase	1%
Capital payment at retirement	30% of the saving capital (vested benefits) at retirement. Many pension fund have this assumption in the bandwidth 20%-40%
Turnover rates	The level 110% of turnover rates published in actuarial tables BVG2015 (in December 2020 the up-date of these tables BVG2020 was published)
Mortality	The level 100% of BVG2015 tables (generational tables, GT)
Disability rates	The level 100% of BVG2015 tables
Retirement age	Males: 65, females: 64

- The most volatile assumption is the Discount rate
- Actuarial assumptions based on actuarial tables are changed every fifth year (BVG2015, BVG2020, BVG2025)
- The up-dated actuarial tables BVG2020 were published at the end of December 2020. For valuation forecast over 2019-2022 assumptions of actuarial tables are based on BVG2015 (because no information were about BVG2020 per 31.12.2019)

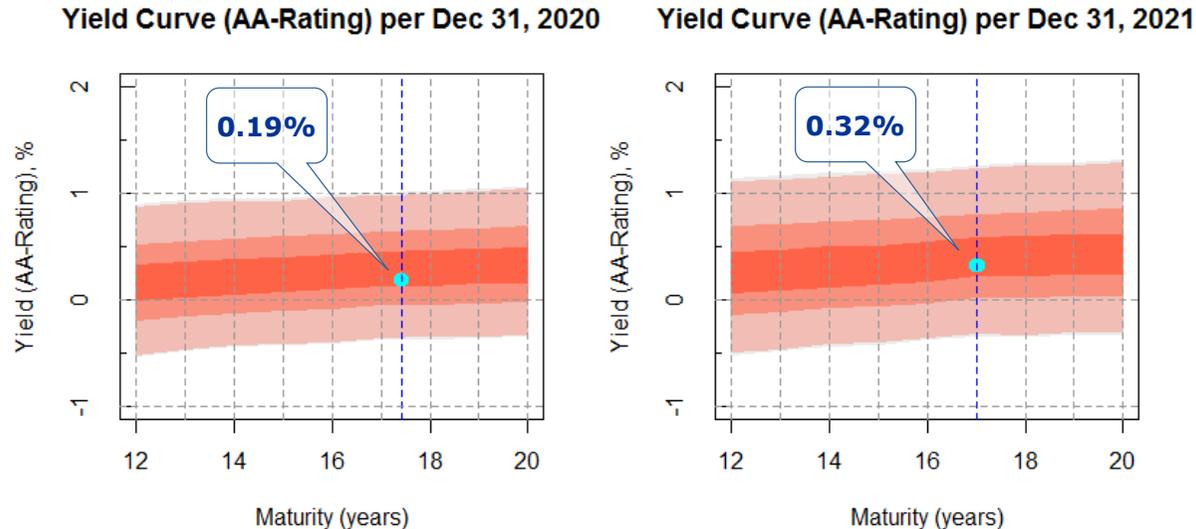
Explanation results

IAS19 Disclosure

- The IAS19 disclosure per December 31, 2019 is a start point
- The Forecast is prepared for the next three years – i.e. up to December 31, 2022
- The blue point shows the results per Dec 31, 2020 and per Dec 31, 2021
 - It helps to verify the quality of forecasting and improve it
- Bandwidths of results: 30%, 60% and 90% - i.e. intervals between percentiles (35-65), (20-80), (5-95)
 - Forecasted values are shown on the background of grey colour compared to the historical values
- Effective situation up to 31.12.2019 (red line up to Bandwidths start on 31.12.2019)

DBO Duration vs. AA Yield Curve

Definition of the Discount Rate in Forecasting



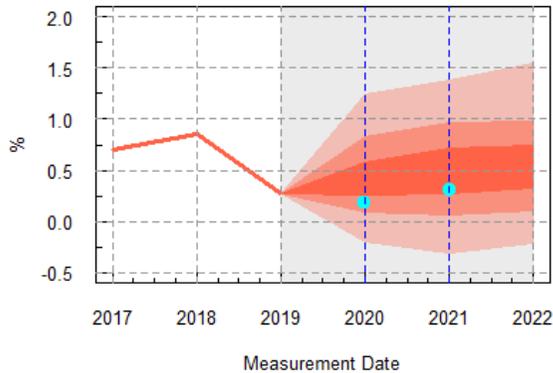
Discount Rate level depends on the liability duration (DBO duration)

- Historical AA Yield Curves per Dec 31, 2020 and per Dec 31, 2021 were a bit flatter compared to the forecasted yield curve
 - That is why the historical position of the discount rate based on the liability duration (*x-axis Maturity*) is in the bandwidth 30% and slightly higher level than 35% percentile
 - The total liability duration depends on the share of DBO pensions vs. DBO active membership. Normally the liability duration of DBO active membership is higher than the liability duration of DBO pensions

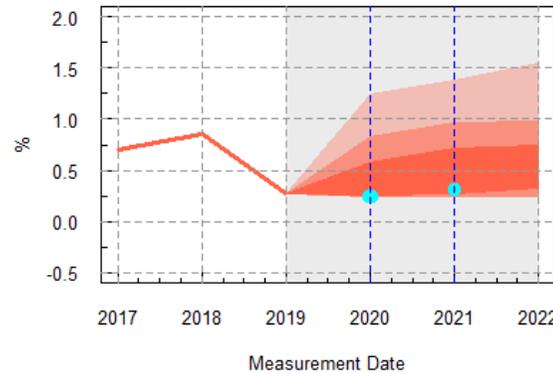
Discount rate, Interest Credit and Liability (DBO) Duration

Light blue (cyan) points show values from IAS19-Disclosures

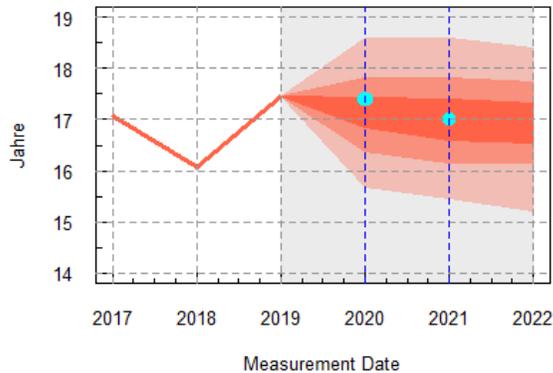
Discount Rate (%)



Interest Credit (%)



DBO-Duration



Interest Credit as assumption

for International Pension Accounting

= max(Discount Rate, mandatory Interest Credit)

Mandatory Interest Credit = 1% * Mandatory saving capital

(here 1% * 25% = 0.25%)

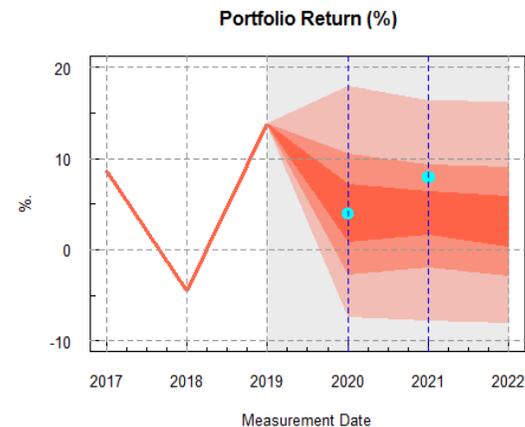
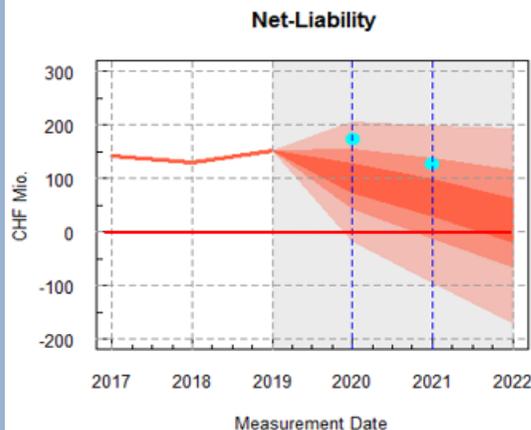
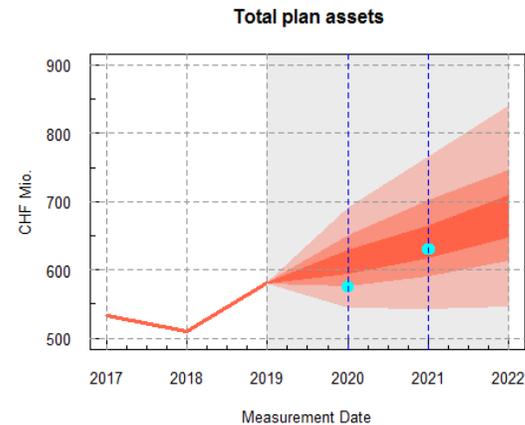
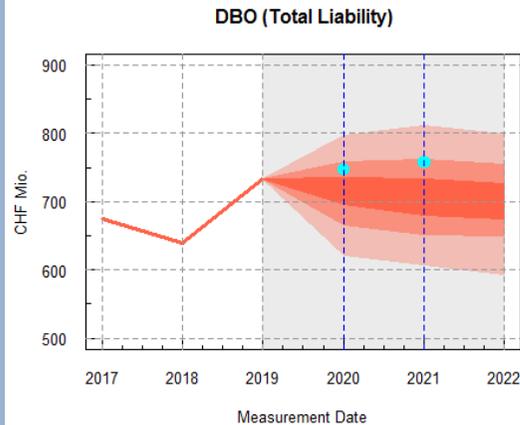
Discount Rates and DBO-Durations are determined based on the forecasted AA Yield Curves per measurement date

- Examples (●) from IAS19 Disclosures
 - Per Dec 31, 2020
 - Per Dec 31, 2021
- The forecast of Discount rates, DBO-Durations and Interest Credits depends on the Model for AA Yield Curve Forecasting
 - Earlier we used an affine model and the bandwidths of forecasted assumptions were wider:
 - For example per 2022 the bandwidth was [-1.0%,2.0%] between 5% and 95% percentiles (i.e. 3% vs. 1.75% based on NNAR)
 - The forecast approach used now is NNAR (Neural Network Autoregression)

Due to the very low Swiss AA Yield Curve level over last years the assumption for Interest Credit is normally lower than real interest credit values. In May 2022 auditors request the forecasting of this assumption based on the local reserving parameters (Swiss GAAP FER 26), portfolio returns and potential development of the local funding ratio (they affect the local interest credit)

Total DBO and Net-Liability, Assets and portfolio return

Light blue (**cyan**) points show values from IAS19-Disclosures

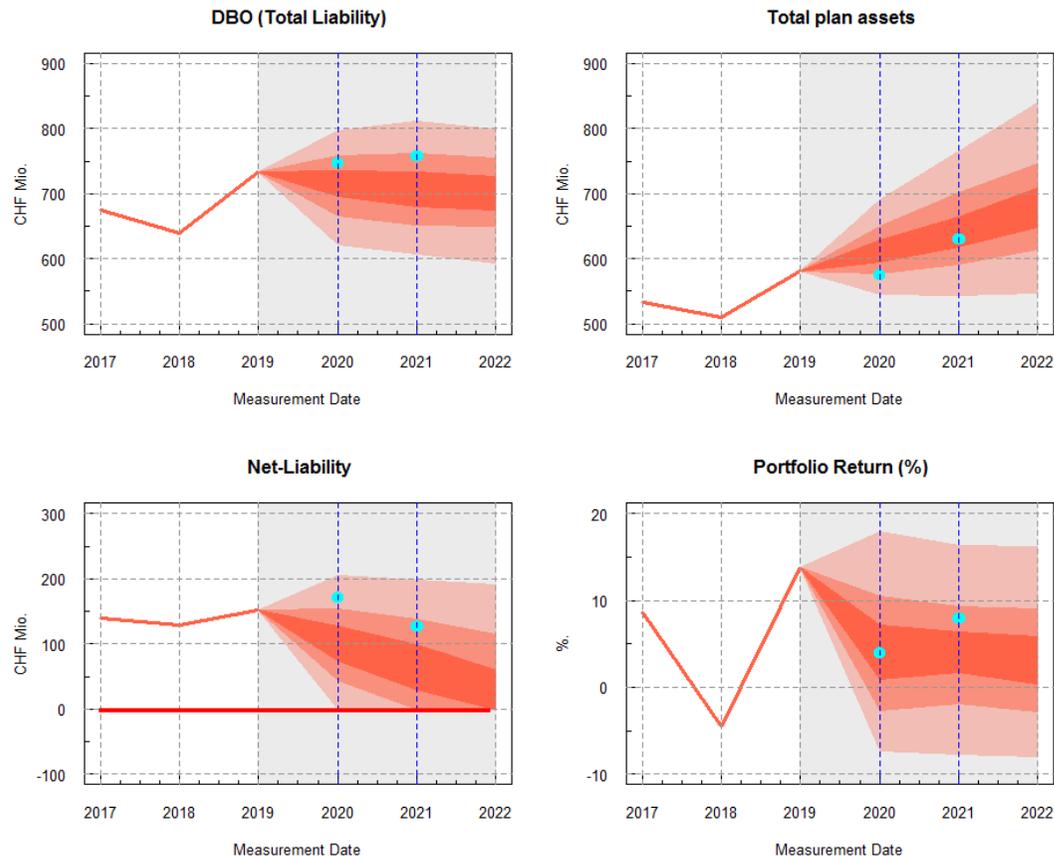


- The forecast is prepared per Dec 31, 2019
- The historical data are from the IAS19 disclosure per Dec 31, 2020 and per Dec 31, 2021
- Many firms were affected in year 2020 by COVID-19
 - Restructuring, retirement, etc.
- The Net-Liability = DBO – Plan Assets
 - **Asset Ceiling *) is not implemented here**
- Portfolio return:
 - In year 2021 portfolio returns of many pension funds were very high

*) Asset Ceiling means that plan assets not available to Company. If Asset Ceiling is implemented the Net-Liability is positive (≥ 0) because its negative value is "subtracted" and added to OCI (i.e. added as assets).

Total DBO and Net-Liability, Assets and portfolio return

Impact Asset Ceiling

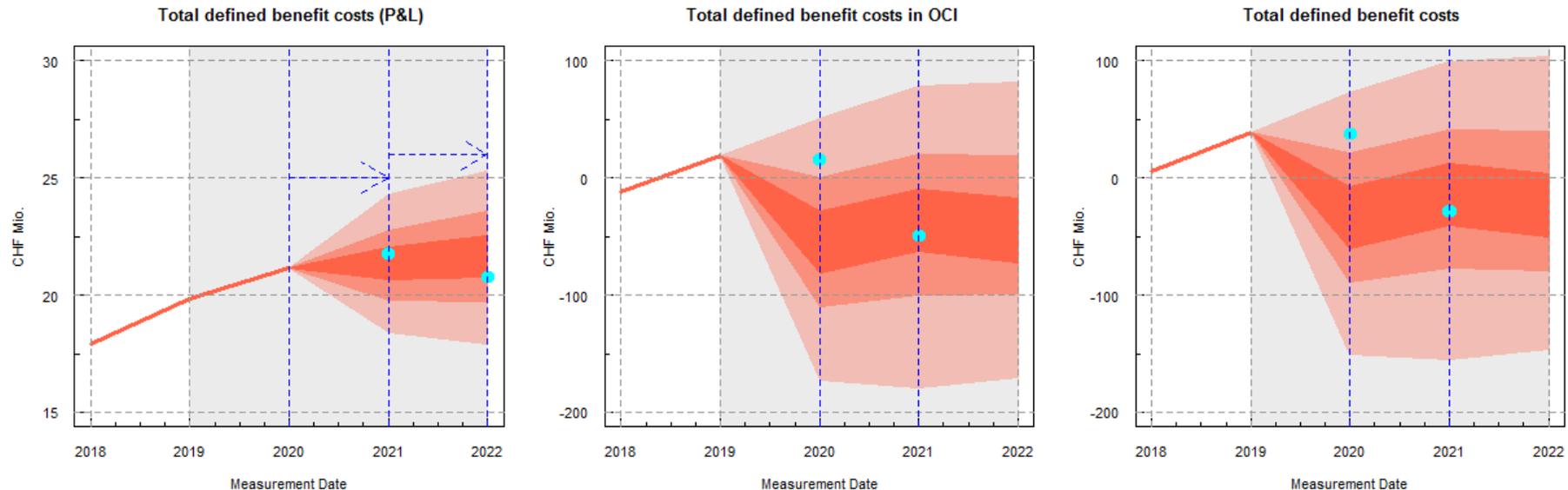


- The forecast is prepared per Dec 31, 2019
- The historical data are from the IAS19 disclosure per Dec 31, 2020 and per Dec 31, 2021
- Many firms were affected in year 2020 by COVID-19
 - Restructuring, retirement, etc.
- The Net-Liability = DBO – Plan Assets
 - **Asset Ceiling *) is implemented**
- Portfolio return:
 - In year 2021 portfolio returns of many pension funds were very high

*) Asset Ceiling means that plan assets not available to Company.
In Switzerland the employer cannot use money from the pension fund (if plan assets is higher than DBO)

Total Defined Benefits Costs: P&L and OCI

P&L (Profit/Loss) and OCI (other comprehensive income)

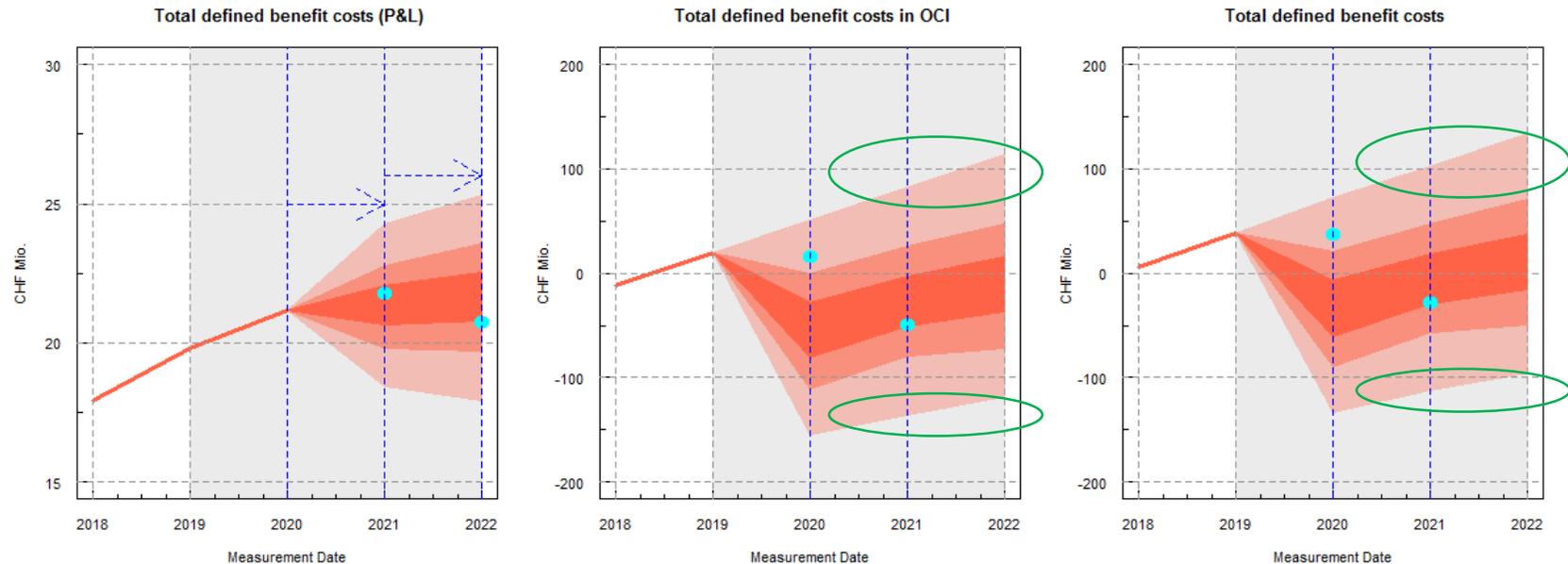


Total Defined Benefit Costs and its Components (**without asset ceiling**)

- The P&L-position per Dec 31, 2020 (MD) is calculated based on assumptions per Dec 31, 2019 (P&L per Dec 31, 2021 on assumptions per Dec 31, 2020 etc.)
 - Due to higher DR per Dec 31, 2021 (0.32%) vs. DR per Dec 31, 2020 (0.19%) the Employer Service Cost is lower and the total position DB Costs P&L is getting lower as well
- OCI Position contains the impact of assumptions change, experience and impact of return on plan assets (excl. Interest Income)
- Total defined benefit costs = P&L-Position plus OCI-Position

Total Defined Benefits Costs: P&L and OCI

Impact Asset Ceiling

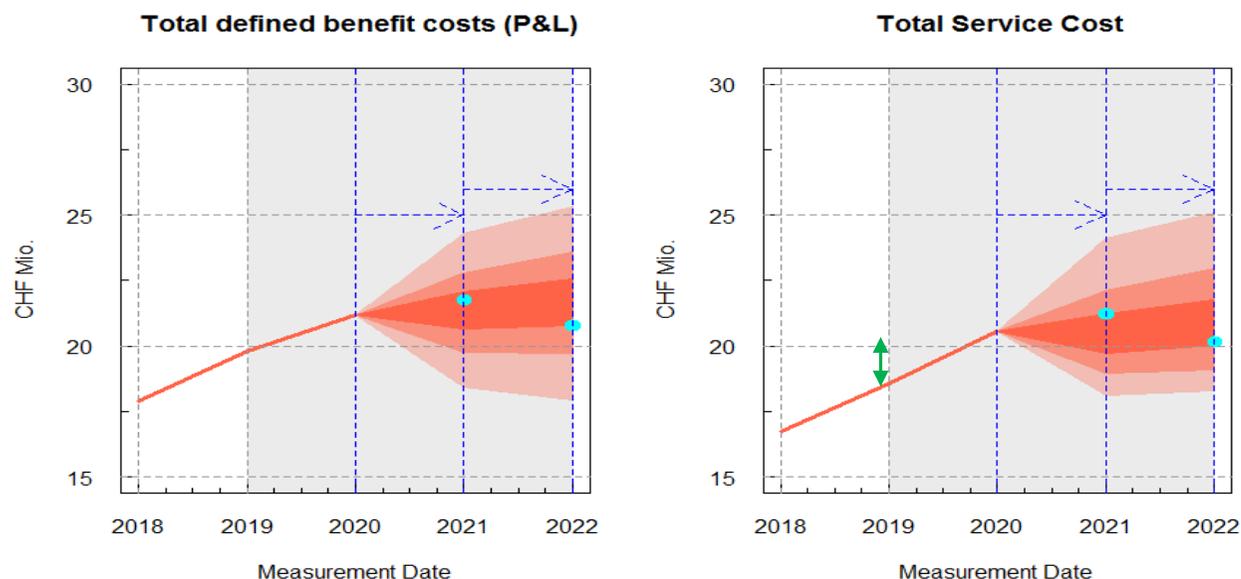


Total Defined Benefit Costs and ist Components (**with asset ceiling**)

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 - Due to higher DR per Dec 31, 2021 (0.32%) vs. DR per Dec 31, 2020 (0.19%) the Employer Service Cost is lower and the total position DB Costs P&L is getting lower as well
- Asset Ceiling impact is added to OCI-Position

P&L Position and its main component Service Cost

P&L: Service Cost and Net Interest



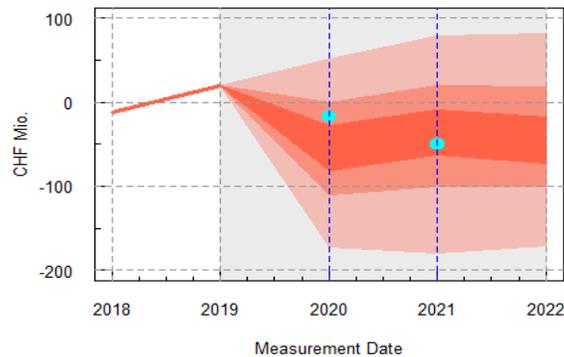
Defined Benefit Costs P&L and its Components

- Service Cost & Net Interest (based on the Discount Rate) & Administration Costs
 - Net Interest is very small compared to the Total Service Cost
 - The level of Net Interest and Administration Costs over the last 3 years was 0.5-1.2 CHF Mio.
- Here: Services Cost corresponds to the Employer Service Cost (in Switzerland the Employee contributions are subtracted from Gross Service Cost)
 - Total Service Cost = Current Service Cost + Past Service Cost + Gain & Losses on plan settlement
 - No plan changes/ no settlement were implemented (i.e. Past Service Cost = 0, G/L settlement = 0)

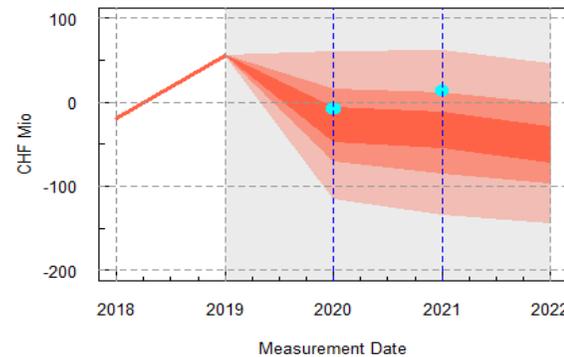
OCI Position and its Component

Change Assumptions, Experience & Return on Plan Assets (excl. Interest Income)

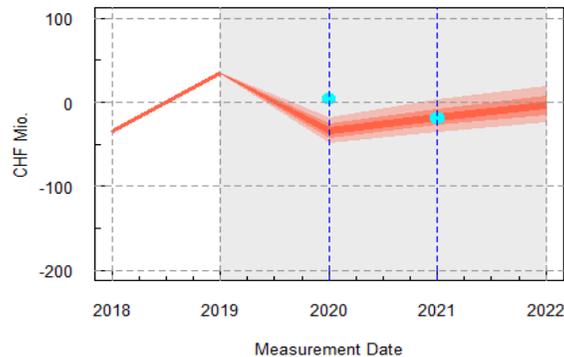
Total defined benefit costs in OCI



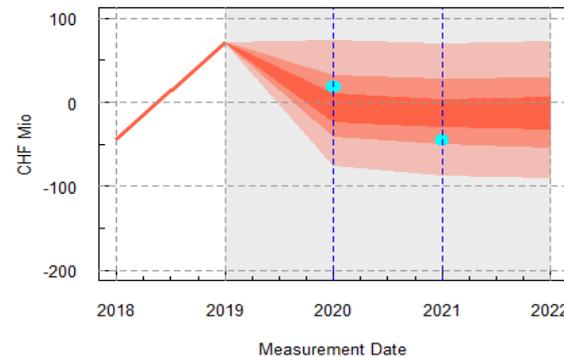
OCI: Financial Gains & Losses



OCI: Experience Gains & Losses



OCI: Return on plan assets (excl. Interest income)



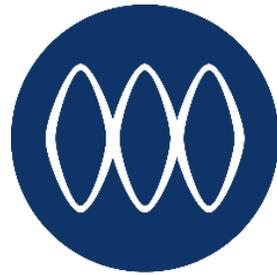
OCI-Position (without asset ceiling)

- Impact change assumptions
 - Here only financial assumptions because no changes of demographic assumptions were implemented
 - Change financial assumptions
 - Here: Discount Rate, Interest Credits and Salary increase – other assumptions not changed
 - Discount rate 0.28% (2019), 0.19% (2020) and 0.32% (2021)
- Experience
 - Impact of COVID-19 in 2020
- The blue points correspond to IAS19-Disclosure results per Dec 31, 2020 and per Dec 31, 2021

Summary

Value added by this approach

- The nested stochastic projections of liabilities produce more realistic forecast of different key metrics for the local (Swiss GAAP FER 26) and international accounting standards (IAS19, US GAAP, IPSAS)
 - Here only membership mutations were implemented;
 - Based on very special COVID-19 experience it is worth realising similar scenarios with other potential pandemics and their impact on financial markets;
- Due to very low (earlier even negative) discount rates it is worth making forecasts of the IFRS/ US GAAP important key metrics (P&L, OCI and other Booking Entities) for the next 1-2 year to explain employer financial teams potential costs and their bandwidths
 - The Discount rate has the strongest impact on DBO liabilities – that is why different approaches should be verified (like here) and correspondingly adjusted/ improved – to get close to reality forecasting
- The results are always pension fund specific and depend on the size of active membership and pensioner population, on development scenarios as well as on the benefit plan scope
 - That is why such pension fund specific results cannot be simply used for other pension funds



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