

# Data Quality & Economic Scenarios Generators



Focus on equity implied volatilities

Milliman & IHS Markit

17 JUNE 2021



1

**Context**

“

To demonstrate the market consistency properties of the ESG, at least some of the following tests should be carried out on the set of scenarios generated by the ESG used for valuation:

- (a) Calibration tests [...];
- (b) Martingale tests [...];
- (c) Correlation tests [...].

”

– EIOPA Guideline 58 on the valuation of technical provisions - Tests

“

Insurance and reinsurance undertakings should ensure that the calibration process of an ESG used for a market consistent valuation is based on data from financial markets that are deep, liquid and transparent

”

– EIOPA Guideline 57 on the valuation of technical provisions - Calibration process

“

Insurance and reinsurance undertakings should be able to demonstrate that the choice of financial instruments used in the calibration process is relevant given the characteristics of [their] obligations

”

– EIOPA Guideline 57 on the valuation of technical provisions - Calibration process

# Context

## Overview of spot market data requirements for risk-neutral Economic Scenarios Generators

01

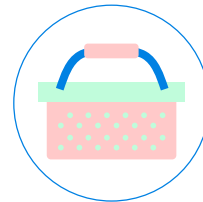
### Nominal interest rates

Spot nominal yield curve

ATM\* and AFM\*\* swaption implied volatilities (or prices).

\*ATM for At The Money

\*\*AFM for Away From the Money



02

### Real rates & Inflation

Spot break-even inflation rate curve (BEIR)



03

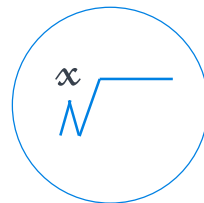
### Real Estate

Volatility parameter

04

### Credit

Spot corporate spreads for different ratings and durations



05

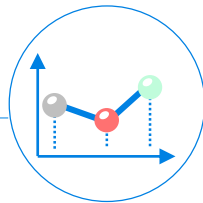
### FX rate

ATM and AFM implied volatilities.

06

### Equity-Like

ATM and AFM implied volatilities.





2

**Data quality**



# Challenges of estimating long term volatilities

Milliman France

June 2021

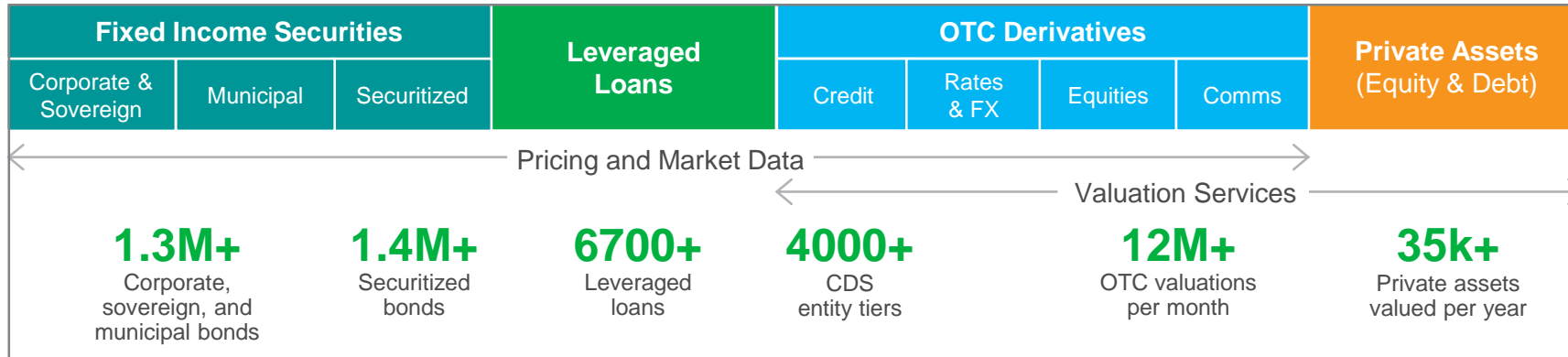


# Agenda

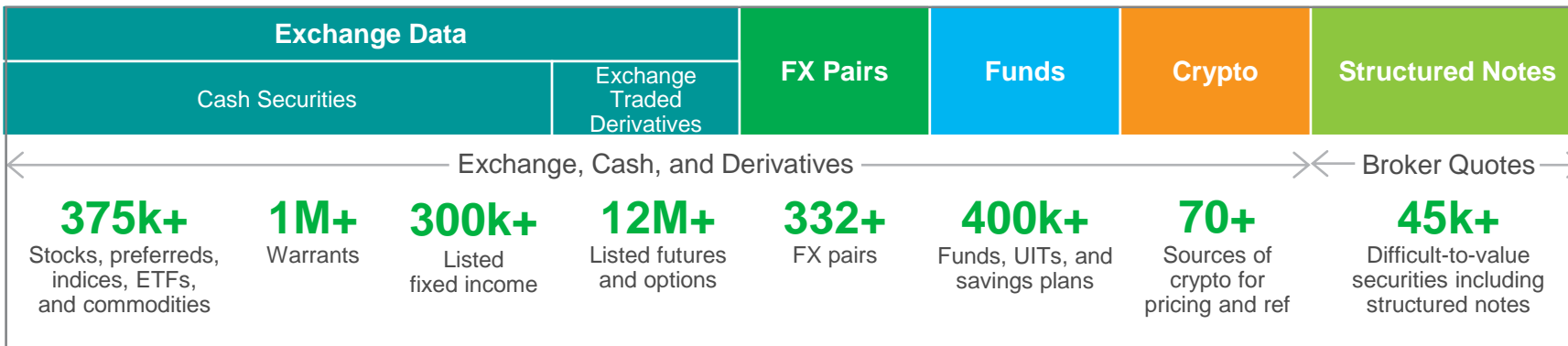
- Introduction - presentation
- Data sources for derivatives markets
- Challenges of estimating long-dated data
- Result examples

## Complete coverage of your portfolio

We have the unique ability to provide customers with asset valuations across the liquidity spectrum of level 2 and 3 assets, with complementary services to help you get the most from your data

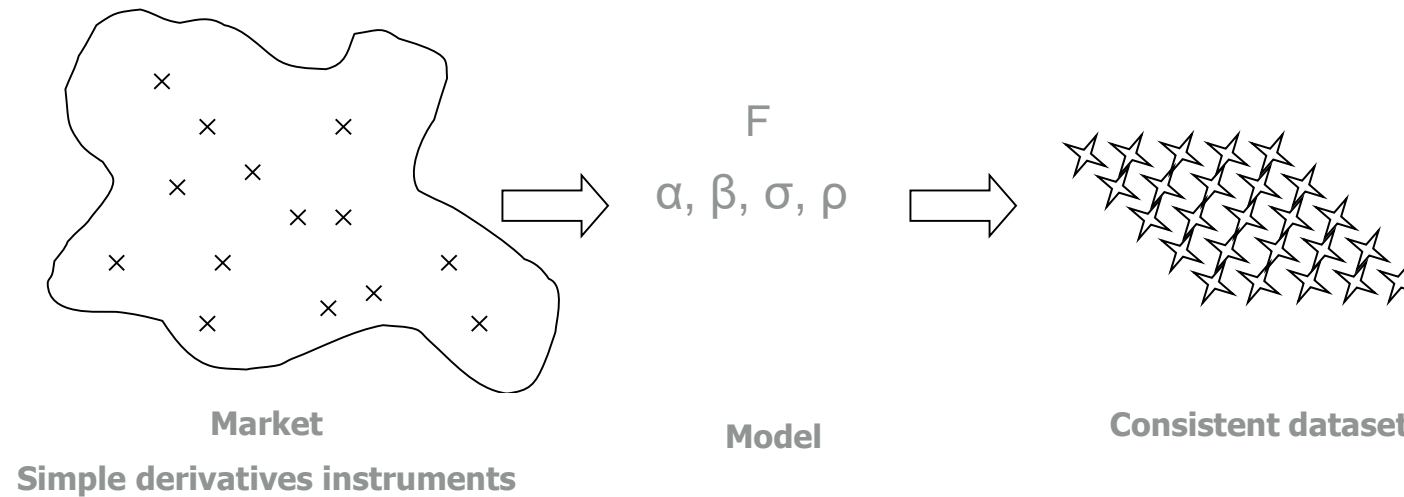


With more than 14 million additional assets priced allowing for complete coverage of your portfolios



## How it works in practice

- We source market information that we model in order to produce datasets suitable for our clients use cases



→ *Sourcing appropriate market information is the real challenge*

## Where can we find market data for derivatives?

### Listed markets

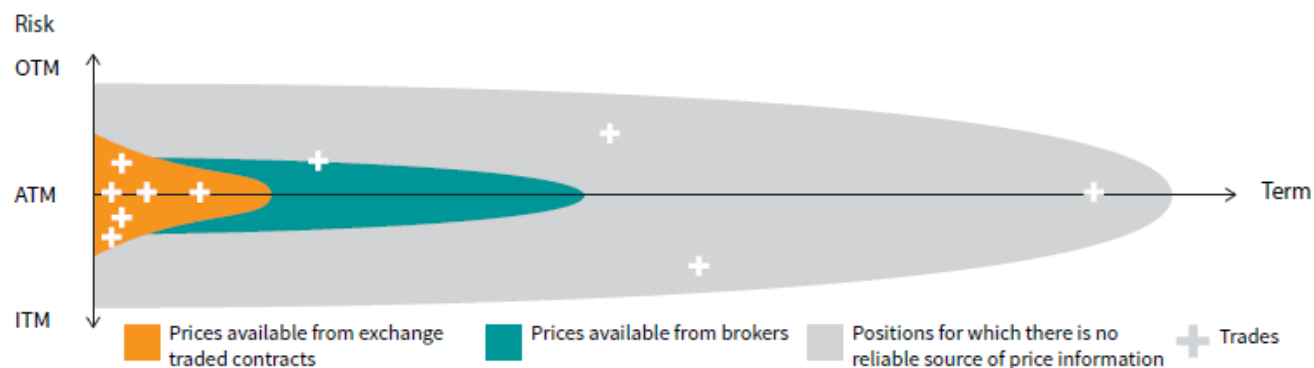
- Organised market
- Standardized instruments
- Market is made by the exchange
  
- Market data can in general be acquired from the exchange
  - > Quotation (pre trade)
  - > Settlement prices
  - > Traded volume information

### OTC Markets

- Decentralized market
- Bespoke instruments
- Market is made by Dealers
  
- Information is scattered and scarce
  - > Brokers
    - There are many brokers
  - > Global trade repositories such as DTCC
    - Regulation depends on region and information is noisy
    - Only post trade information

## The problem that we need to solve

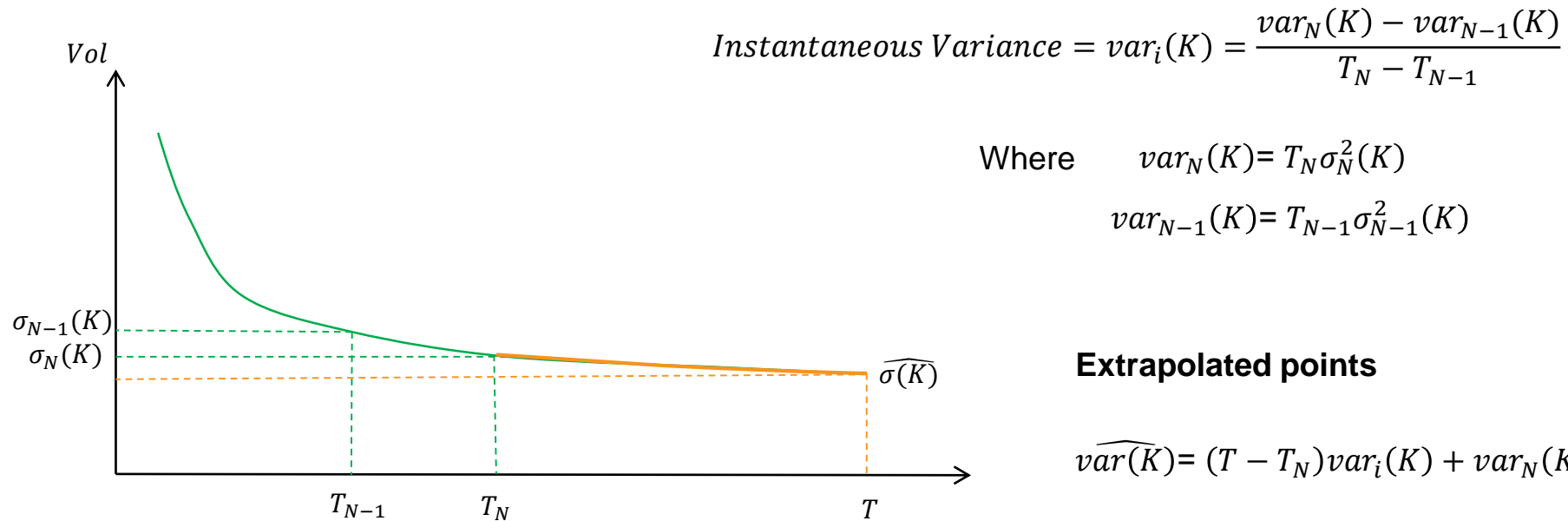
Typical derivatives trading portfolio



- How and where can we find information for the instruments corresponding to the grey area?

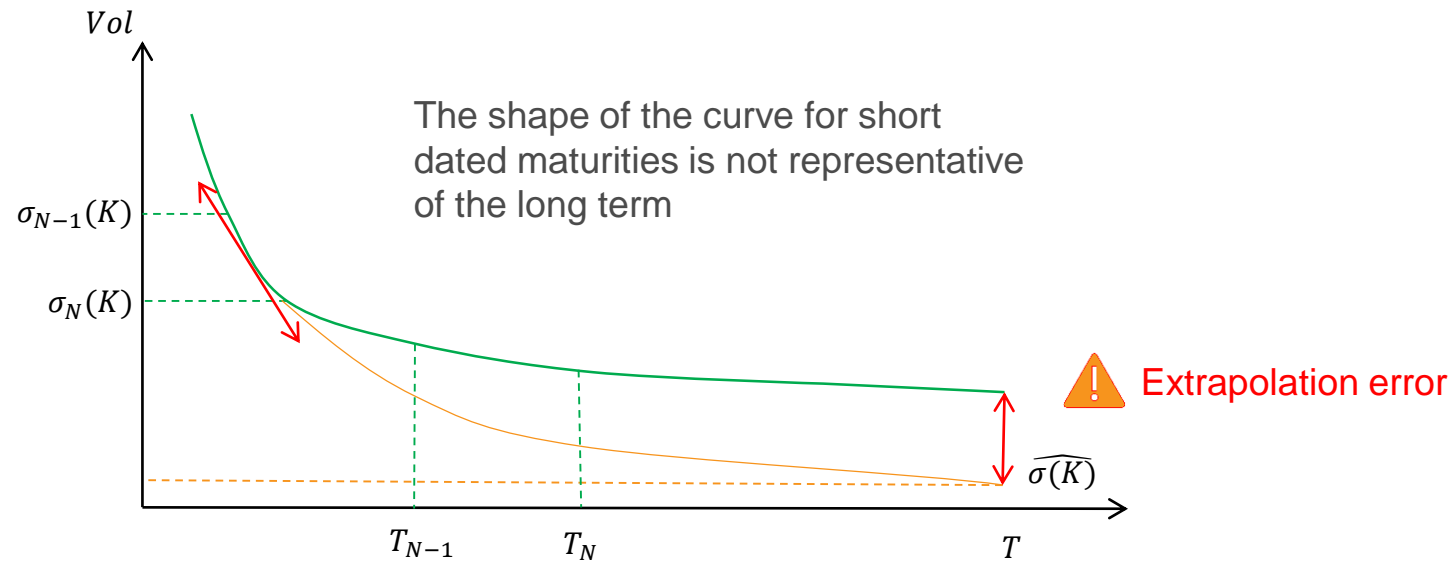
## Can extrapolation be the solution?

- Flat extrapolating the instantaneous variance for each strike  $K$  beyond last observed point



## And if there is a lack of long dated market data...

- The quality of the extrapolation depends on the information contained in the initial sample



### Problem

Listed markets only cover short term maturities

## Limitations of listed markets

- Listed markets offer a range of maturities and strikes
  - > In practice only a few are liquid
- Example of maximum listed maturities used in our datasets as of Nov-end 2020

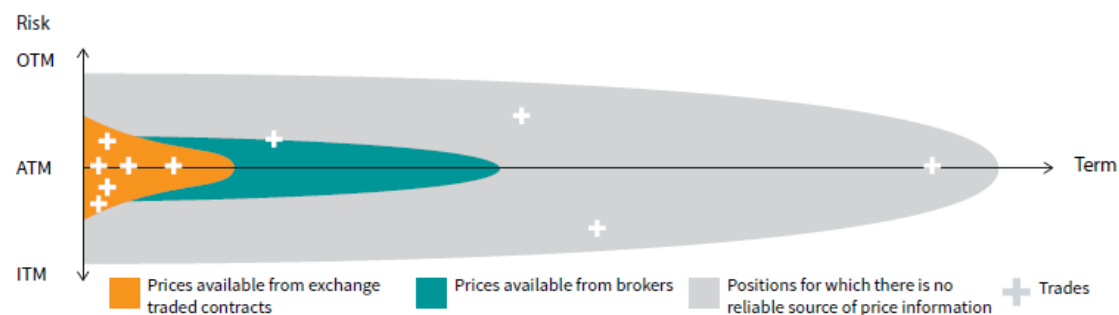
Index	Max used listed expiry	Maturity
EURO STOXX 50	Dec 2024	4Y
STOXX:BANKS	Dec 2022	2Y
SMI	Jun 2022	18M
S&P 500	Dec 2022	2Y
NIKKEI 225	Jun 2021	6M
CAC 40	Dec 2021	1Y



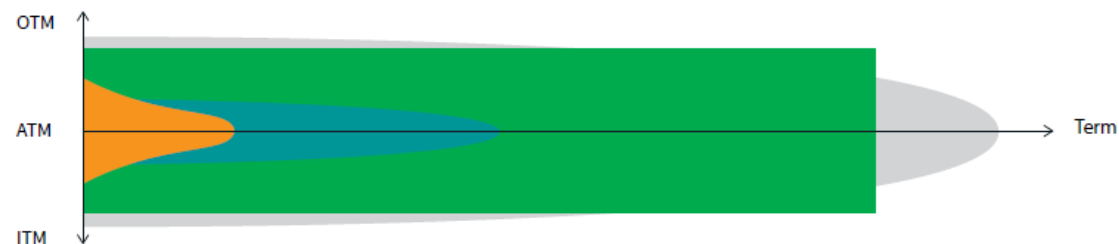
## Game changer: introducing a new data source

- Unique access to a consensus of market dealer marks on derivatives

Typical derivatives trading portfolio



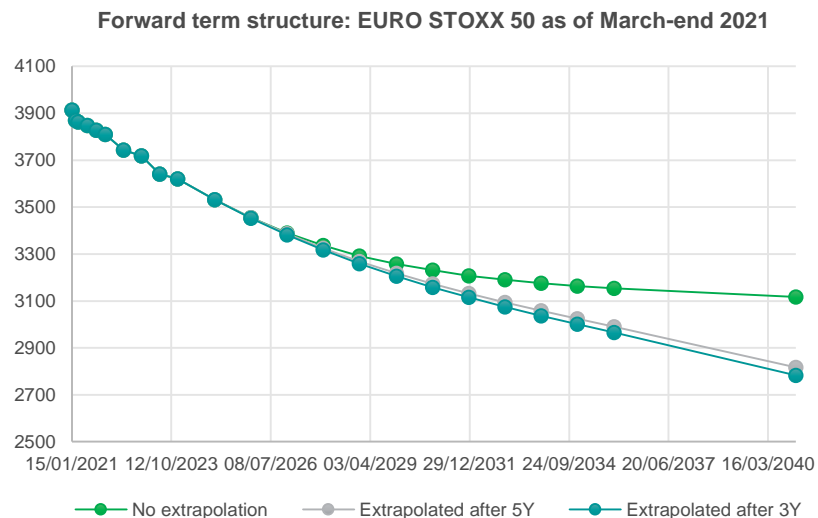
Our coverage



### Our solution

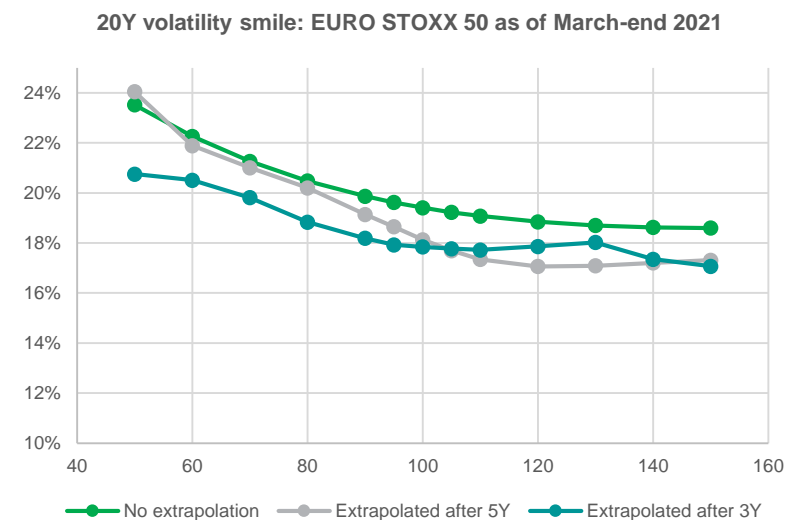
Blending exchange information and market maker consensus information for best quality and coverage

## Result examples



- Up to 2.7% difference on the volatility for some strikes
- 1.5% difference around the money

- Dividends are significantly overestimated with extrapolation
- Extrapolated forward is almost 11% lower than the non extrapolated one



## Disclaimer

The information contained in this presentation is confidential. Any unauthorized use, disclosure, reproduction or dissemination, in full or in part, in any media or by any means, without the prior written permission of IHS Markit or any of its affiliates ("IHS Markit") is strictly prohibited.

Opinions, statements, estimates and projections in this presentation (including other media) are solely those of the individual author(s) at the time of writing and do not necessarily reflect the opinions of IHS Markit. Neither IHS Markit nor the author(s) has any obligation to update this presentation in the event that any content, opinion, statement, estimate or projection (collectively, "information") changes or subsequently becomes inaccurate.

IHS Markit makes no warranty, expressed or implied, as to the accuracy, completeness or timeliness of any information in this presentation, and shall not in any way be liable to any recipient for any inaccuracies or omissions. Without limiting the foregoing, IHS Markit shall have no liability whatsoever to any recipient, whether in contract, in tort (including negligence), under warranty, under statute or otherwise, in respect of any loss or damage suffered by any recipient as a result of or in connection with any information provided, or any course of action determined, by it or any third party, whether or not based on any information provided.

The inclusion of a link to an external website by IHS Markit should not be understood to be an endorsement of that website or the site's owners (or their products/services). IHS Markit is not responsible for either the content or output of external websites.

Copyright ©2020, IHS Markit. All rights reserved and all intellectual property rights are retained by IHS Markit.

3

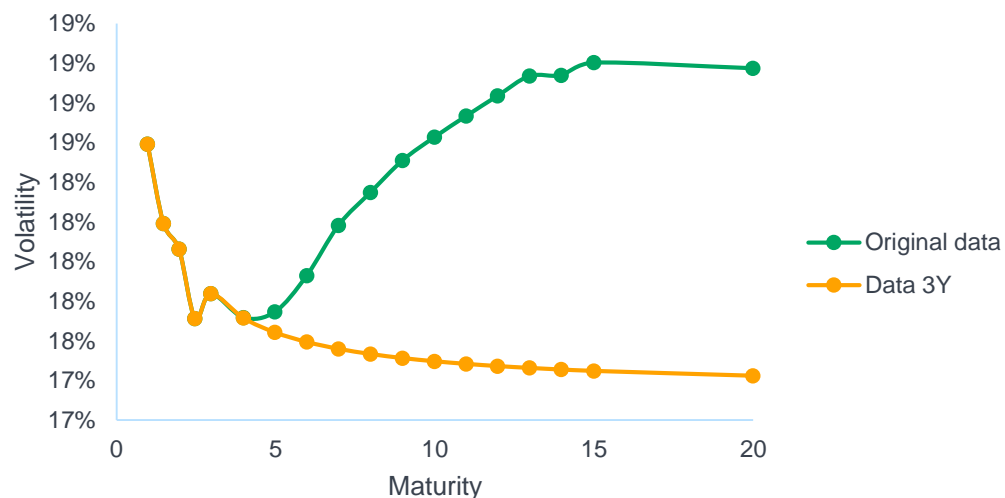
Impacts

# Impact on valuation and solvency ratio

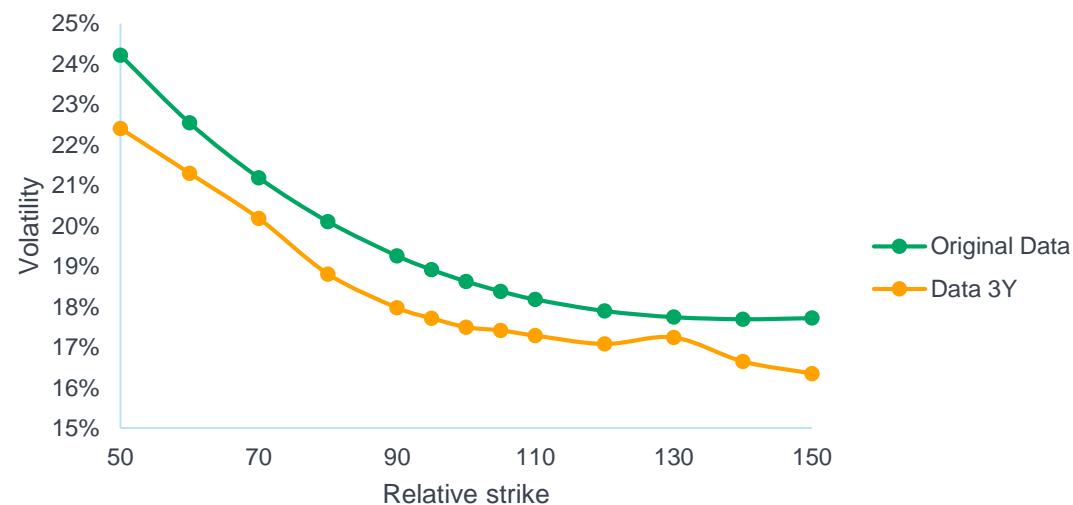
## Datasets considered

- The study relies on our [France Vie](#) ALM model which is representative of the French market
- The Economic Scenarios are calibrated and simulated with [Milliman CHES](#)
- The two datasets considered for equity implied volatilities are the [original](#) and [mis-extrapolated](#) data below:

ATM equity implied volatilities as at 31.12.20



AFM (10Y) equity implied volatilities as at 31.12.20



# Impact on valuation and solvency ratio

## Quantitative analysis

- Own funds and solvency ratio differences using a **Black-Scholes model with time-dependent volatility** (ATM data only)

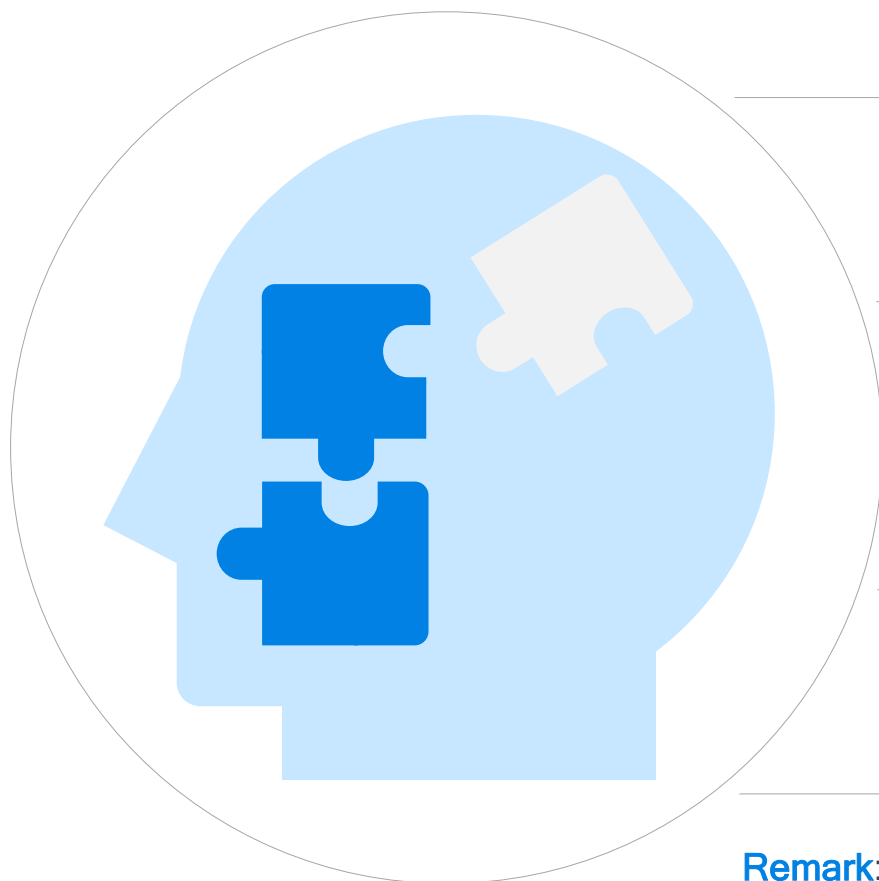
	Own Funds	Solvency Capital Requirement	Solvency Ratio
<b>Data original</b>	0%	0%	0%
<b>Data 3Y</b>	+3% relative	-2% relative	+6% additive

- Own funds and solvency ratio differences using a **Stochastic Volatility with Jump Diffusion** (ATM & AFM data) are of comparable orders of magnitude

# Focus on correlations

## Overview of the estimation approach

- Implementation of a dedicated approach for the ESG correlation coefficients estimation:



Estimation of **target correlations between observable risk factors** (rates variations, discounted log-return, ...).

*This step relies on the study of historical time series. It generates the so-called **target correlation matrix***

1

Characterization of the **analytical expression of correlation between observable risk factors as a function of the correlation between Brownian motions and the model parameters**.

*This step depends on the retained model and gives the so-called **ESG correlation matrix***

2

Step 2 allows to estimate the correlation parameters 2 by 2. Thus **the resulting matrix might be not positive semi definite (PSD)**.

*An adjustment can be necessary (use of Higham method).*

3

**Remark:** the virtue of the closed-form approach is to limit the number of iterations using the ESG, which contrasts with other methods (e.g. calibration of a proxy response function to capture the link between target and ESG correlation matrix).

# Focus on correlations

What may happen under volatility shocks for stochastic volatility models with jumps?

- Context:

- The standard SVJD (Stochastic Volatility Jump Diffusion) model relies on a (compensated) compound Poisson component that is assumed independent from other risk drivers (interest rate, real rates, property, credit,...)
- As a consequence, the stochastic volatility component is used to capture correlations with other risk drivers, in order to match prescribed historical targets on correlations

$$\frac{dS(t)}{S(t)} = r(t)dt + \sqrt{V_t}dW_t + (J_t - 1)dN_t - \lambda\mathbb{E}[J_t - 1]dt$$

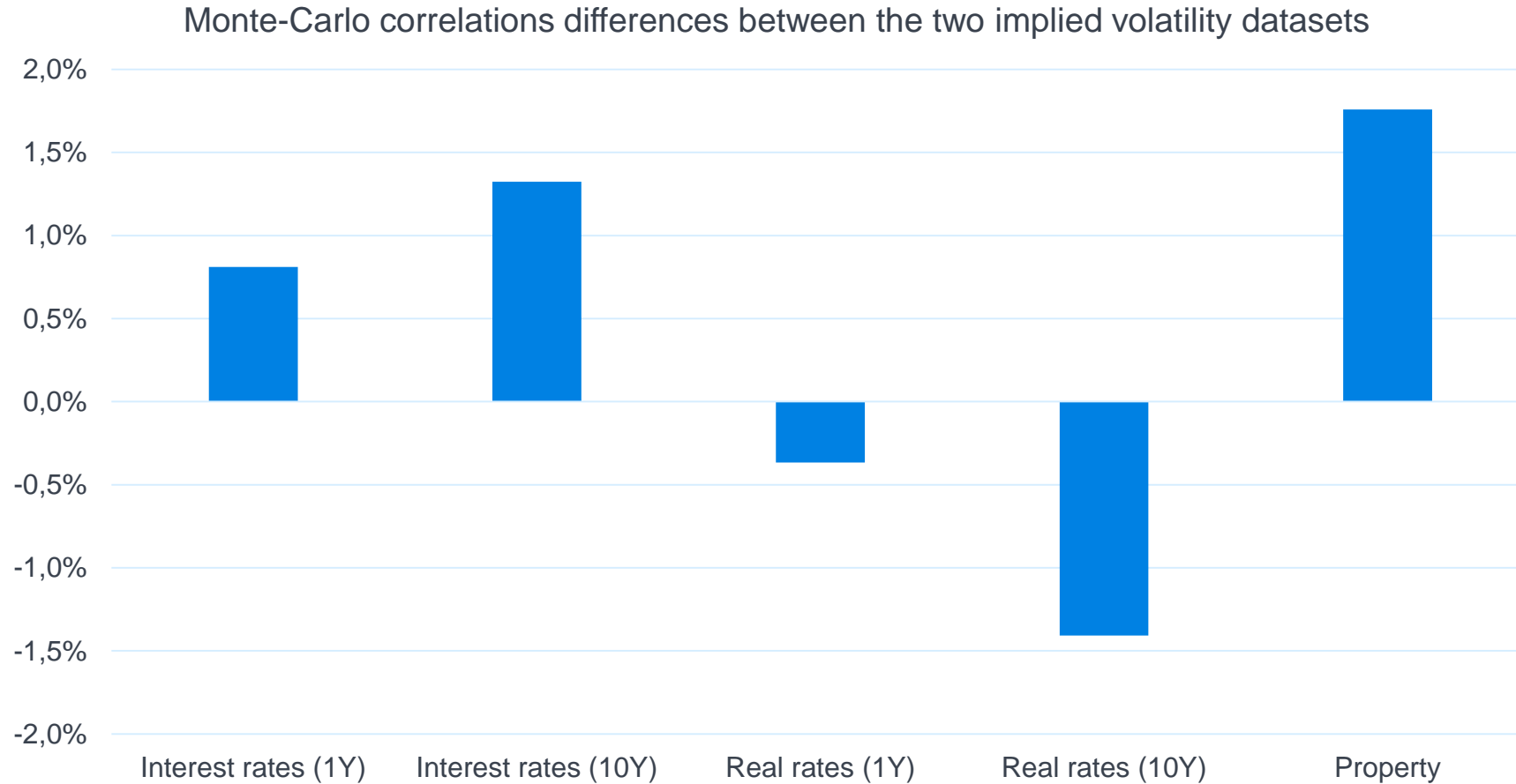
- Issue:

- As the volatility term structure and/or skew change, the share of variance driven by the stochastic volatility component may fluctuate, leading to distort correlations → we illustrate such an issue in the next slide
- The solution to this issue relies on a proper recalibration of the ESG correlation matrix under updated market conditions and/or a relevant control on the model parameters



# Focus on correlations

Impacts of mis-estimated volatilities in case correlation calibration is not controlled



**DANS UN CONTEXTE RÉGLEMENTAIRE EXIGEANT, LA TRANSPARENCE EST PRIMORDIALE.** Le générateur de scénarios économiques cloud Milliman CHESSE est à la pointe des pratiques de marché et des dernières innovations en matière de modélisation financière. Milliman CHESSE garantit l'auditabilité et la traçabilité des calculs tout au long du processus de production des scénarios économiques. Oubliez les boîtes noires et choisissez l'exigence : [chess@milliman.com](mailto:chess@milliman.com)

Milliman **CHESSE**<sup>®</sup>



# Disclaimer

*This presentation presents information of a general nature. It is not intended to guide or determine any specific individual situation and Milliman recommends that users of this presentation will seek explanation and/or amplification of any part of the presentation that they consider not to be clear. Neither the presenter nor the presenter's employer shall have any responsibility or liability to any person or entity with respect to damages alleged to have been caused directly or indirectly by the content of this presentation. All persons who choose to rely in any way on the contents of this presentation do so entirely at their own risk.*

*The contents of this presentation are confidential and must not be modified, copied, quoted, distributed or shown to any other parties without Milliman's prior written consent.*

*Copyright © Milliman 2021. All rights reserved*