ACTUARIS
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Risk & insurance solutions

Adjusting economic scenarios within the ORSA framework

Châtaigner Benjamin, Haguet Eléonore

13/15 Boulevard de La Madeleine | 75001 Paris | Tél : +33(0)1 56 89 07 70 | Fax : +33(0)1 56 89 07 70
46 bis chemin du Vieux Moulin | 69160 TASSIN | Tél : +33 (0)4 72 18 58 58 | Fax. : +33 (0)4 72 18 58 59

Summary

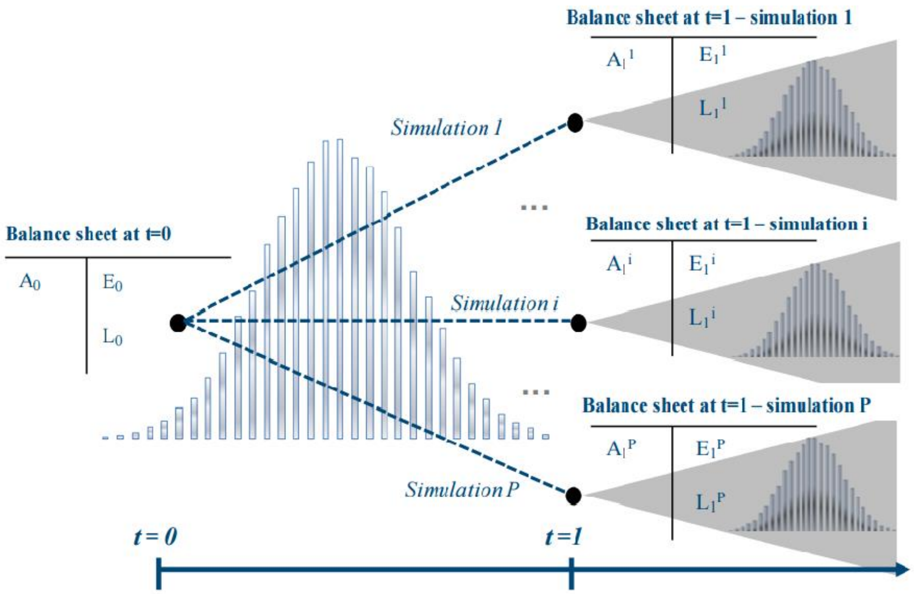
- Part 1 : General Context
- Part 2 : The financial adjustments
- Part 3 : Numerical application

General context

Solvency 2 calculation risks

- In the Solvency 2 regulation, insurers have to compute the economic capital to demonstrate their solvency with a 99.5 % certainty at a one year horizon.

- In order to do this, they can use:
  - The standard formula
  - An internal model (partial or complete)



- ✓ Real world simulations to forecast the activity.
- ✓ Risk neutral simulations are used to take into account the time value of financial options and guarantees.

This algorithm is very time consuming especially within the pillar 2 framework.

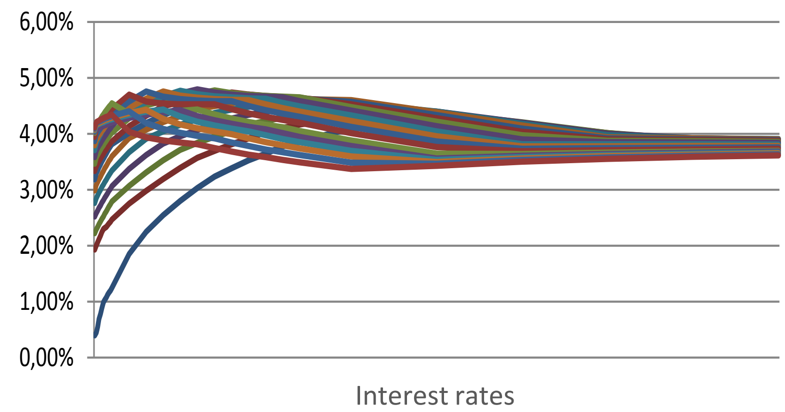
Illustration taken from Risk aggregation in Solvency II by *L.Devineau and S.Loisel*

General context

Economic Scenarios Generator

❖The Economic Scenarios Generator (ESG) is used to simulate economic risk factors at future time steps :

- ❖ Equity markets
- ❖ Property markets
- ❖ Credit
- ❖ Interest rates
- ❖ Price inflators
- ❖ Currency



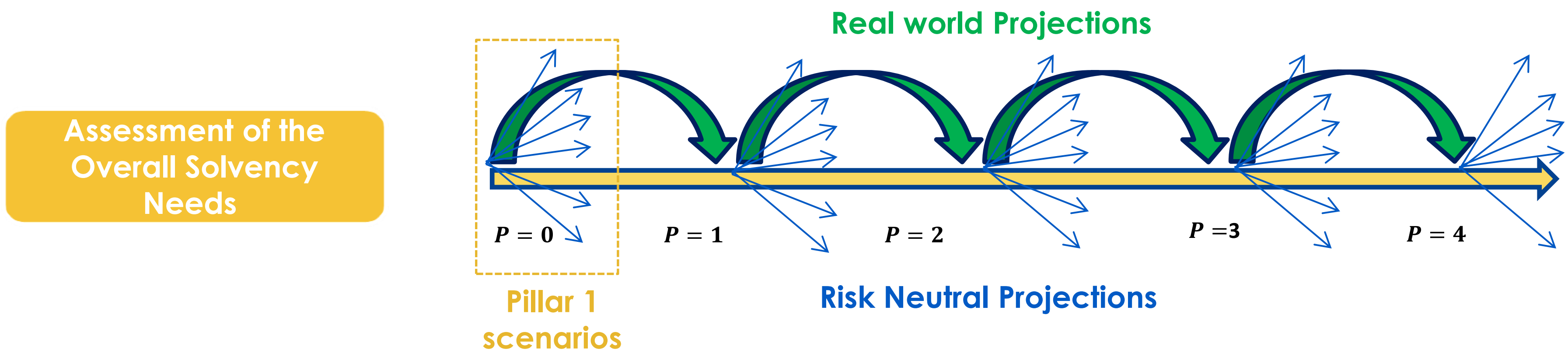
❖ … Stochastic projections of financial and economic variables :

$$\Theta^* = Argmin \sum_i \|MarketPrices(i) - ModelPrices(i)\|^2$$

❖<u>**Ongoing adequation of the ESG:**</u> companies set up procedures to make sure that the ESG remains permanently appropriate to calculate the technical provisions.

General context

ORSA model



- **Real world Projections** : Risk factors evolution according to the central scenario and stress scenarios:
  - Central scenario, Conservation of low yield rates scenario, Sudden increase of the yield rates scenario…

- **Risk Neutral Projections** : Stochastic scenarios used to calculate the Best Estimate of Liabilities.

- Difficulty : How to generate Risk Neutral projections at every time step according to the Real World evolution of the risk factors?

General context

Calculation of stochastic scenarios

- Theoretical approach : Economic scenarios generator calibration at every time step
    - Difficulty : Future market prices are not available.

- Alternative Method : Financial adjustments
    - An unique set of economic scenarios is used, which are those needed for the Pillar 1 calculations.
    - Application of a stochastic factor, depending on the real world, to the risk neutral scenarios.

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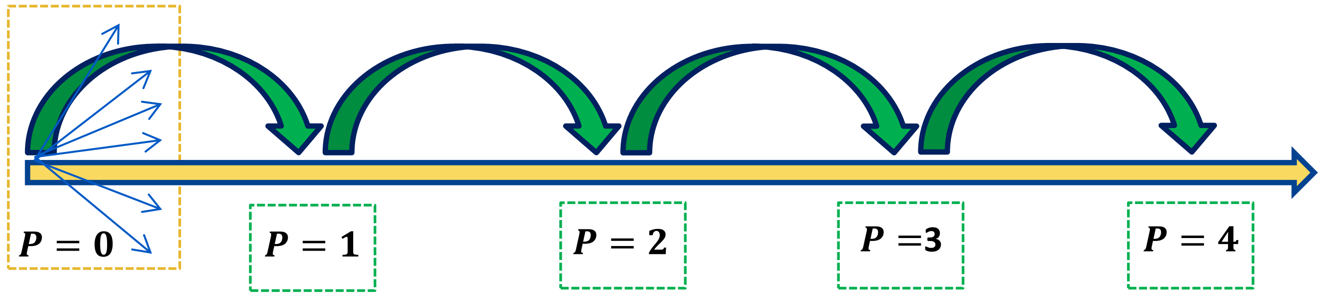
The financial adjustments

ORSA Framework

Stochastic hazard



Pillar 1 scenarios :
Initial Market Prices

Evolution through the strategic plan : New market conditions

For every stress test.

Analytical method
Financial adjustments

- ✓ Deformation of the hazard generated for the Pillar 1 calculations, according to the evolution through the strategic plan
- ✓ Reconciliation with the market conditions at every time step of the business plan
- ✓ Under this new probability measure, risk factors should be martingale.

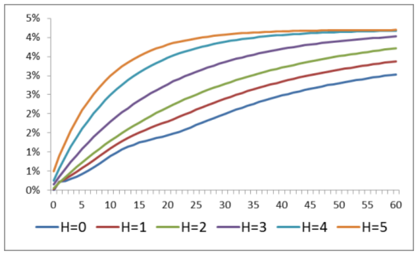
The financial adjustments

The financial adjustments in an ORSA model

Method : Application of a stochastic factor, depending on the Real World scenario, to the risk-neutral discount factor.

1st step

Business Plan assumptions:
- **Central scenario**
- **Stress scenarios**



2nd step

Use of Pillar 1 economic scenarios

« Base Table »

3rd step

Adjustment of the Risk Neutral « Base Table »

Stochastic Factor

Risk neutral yield rates curve at every time step

Undertakings calculation and prospective Risk Capital

This method does not need any additional economic scenario compared to those used for the Pillar 1 calculations.

The financial adjustments

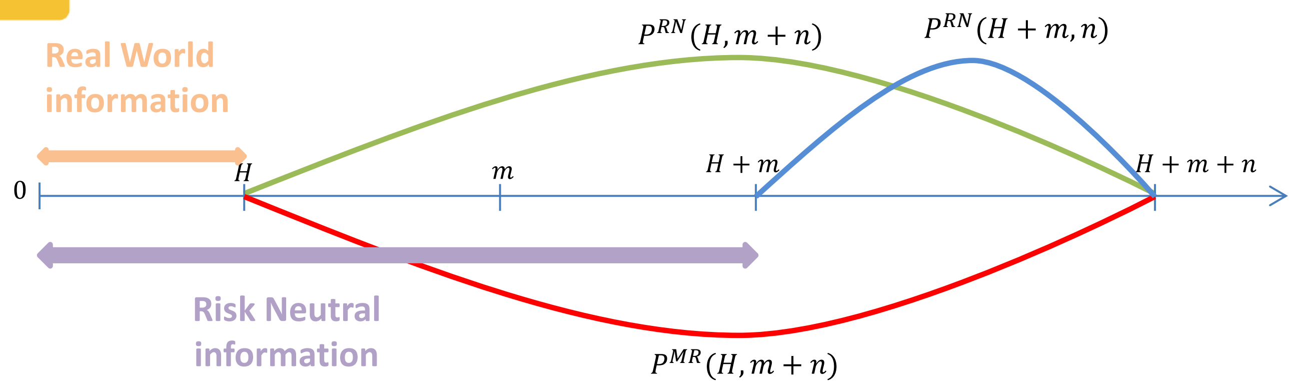
Theory of the financial adjustments

Ajustement de niveau

The financial adjustments apply a **stochastic factor** to the Risk Neutral scenarios used within the Pillar 1.

This stochastic factor depends on the **Real Word** scenario used to forecast the economic activity of the company.

Information timeline



Adjustment formula

$$\hat{P}(H+m,n) = P^{RN}(H+m,n) \times \frac{\frac{P^{MR}(H,m+n)}{P^{MR}(H,m)}}{\frac{P^{RN}(H,m+n)}{P^{RN}(H,m)}}$$

Stochastic factor

The financial adjustments

Theory of the financial adjustments

The financial adjustments create yield rates curves allowing the company to assess its Best Estimate of Liabilities throughout the strategic plan, with the economic scenarios used within the Pillar 1.

Assessment of future liabilities

$$\widehat{D}(H,n) = \prod_{i=0}^{n-1} \widehat{P}(H+i,1) \Rightarrow BEL_H = E^Q\left(\sum_{u\geq 1}^{P} \widehat{D}(H,u) \times Flux_{H+u}\right)$$

These adjustments can also be applied to the equity, property and inflation factors.

Equity and Property adjustment formula

$$\hat{S}(H+n) = S^{RN}(H+n) \times \frac{D^{RN}(H,n)}{\widehat{D}(H,n)}$$

Inflation adjustment formula

$$\hat{I}(H,n) = I^{RN}(0,H+n) \times \left(\frac{1+ln\big(1+ZCIS_{MR}(H,n)\big)}{1+ln\big(1+ZCIS_{RN}(H,n)\big)}\right)^n$$

Where $ZCIS_{**}(H,n)$ is the Zero Coupon Swap Inflation

The financial adjustments

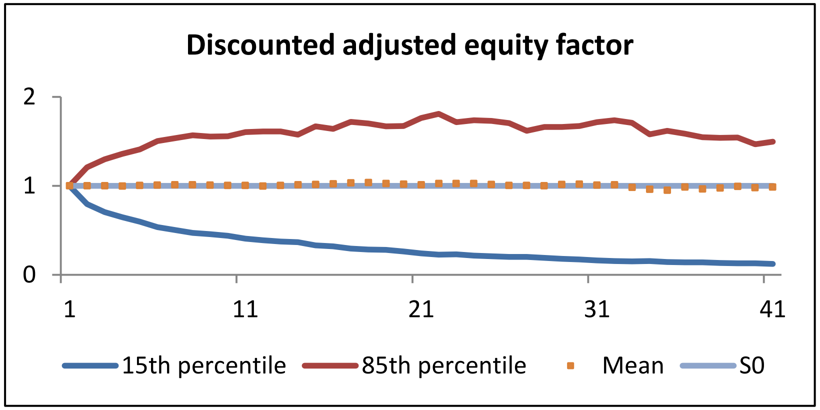
Properties of the financial adjustments

The financial adjustments are meant to keep the mathematical properties of the Risk Neutral scenarios.

Martingale property

Considering the equity factor :

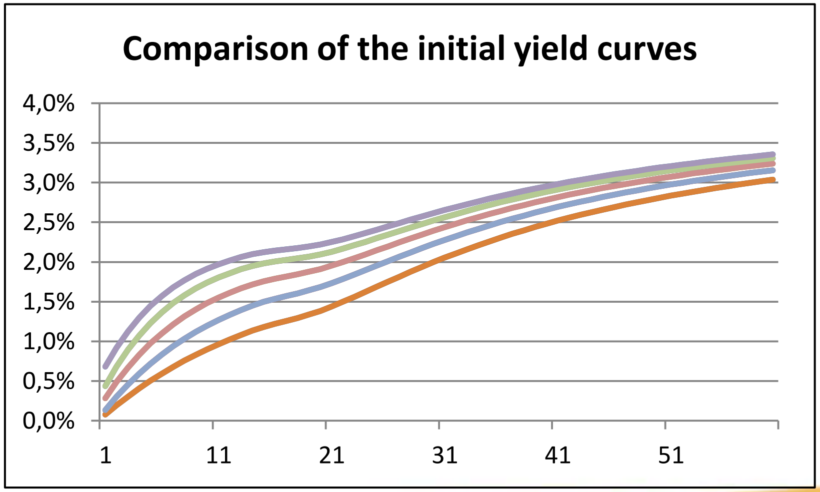
$$\mathbb{E}^{\mathbb{Q}}\left(\hat{S}(H+n) \times \widehat{D}(H,n) \middle| \mathcal{F}_H\right) = S^{MR}(H)$$



Risk factors reconciliation

Considering the equity factor :

$$\hat{P}(H) = P^{MR}(H)$$



The financial adjustments

Yield rates extrapolation : the Smith Wilson method

Within the Pillar 1, the liabilities are assessed thanks to the EIOPA yield rates curve, issued from the Smith Wilson method.

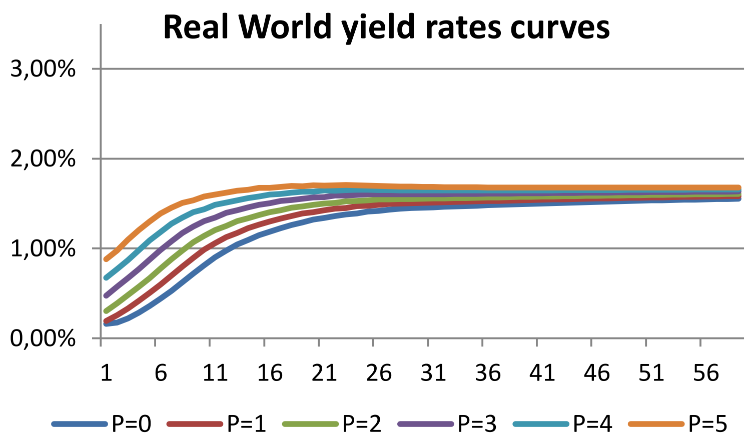
- Method of interpolation and extrapolation of the market yield rates curve, up until the Last Liquid Point (LLP) and further. This method necessitates forward rates.
- Convergence to the Ultimate Forward Rate (UFR) representing the limit of the forward rates at high maturities. It is currently equal to 4.2%.
- A duration of convergence to the UFR (currently set at 40 years).

This algorithm is yearly used by the EIOPA in order to deliver the yield rates curve used for the assessment of the liabilities.

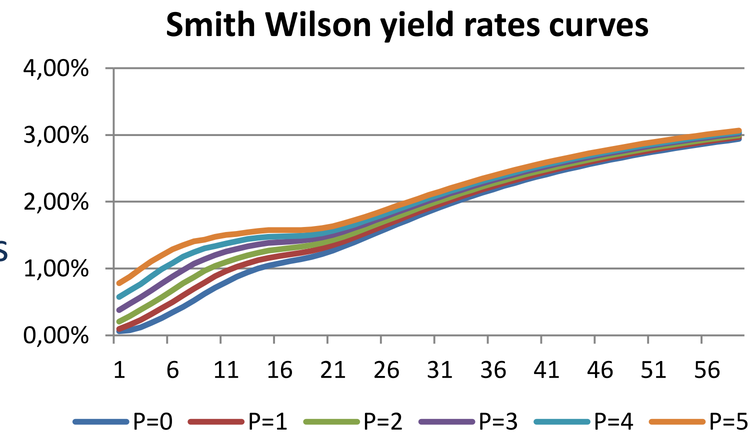
The financial adjustments method

Properties of the adjustments

- The financial adjustments aimed at computing the prospective commitments of the insurer. It would be legitimate to remain consistent with what is used for the pillar 1 calculations.



Extrapolation of the Real World yield rates curves



- Introducing the extrapolated yield rate curves in the stochastic factor :

$$\hat{P}(H+m,n) = P^{RN}(H+m,n) \times \frac{\frac{P^{SW}(H,m+n)}{P^{SW}(H,m)}}{\frac{P^{RN}(H,m+n)}{P^{RN}(H,m)}}$$

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Numerical application
ORSA Model

Pension model

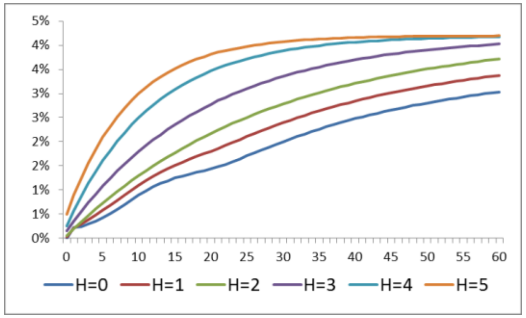
- ✓ Long term undertakings :
  - ❑ Duration of the liabilities : 20 years,
  - ❑ Duration of the assets : 14 years
- ✓ Taking into account the revaluation
- ✓ Classical assets allocation
- ✓ Initial balance sheet of the insurer :

Assets	Liabilities
MV =4 553m€	OF = 401 m€
	BE = 4 152 m€

Business Plan assumptions

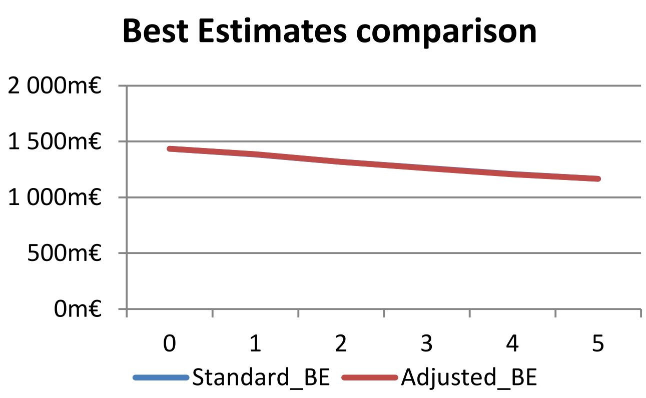
- ✓ 5 years strategic horizon
- ✓ Supposed evolution of the yield rates getting higher.
- ✓ Standard formula

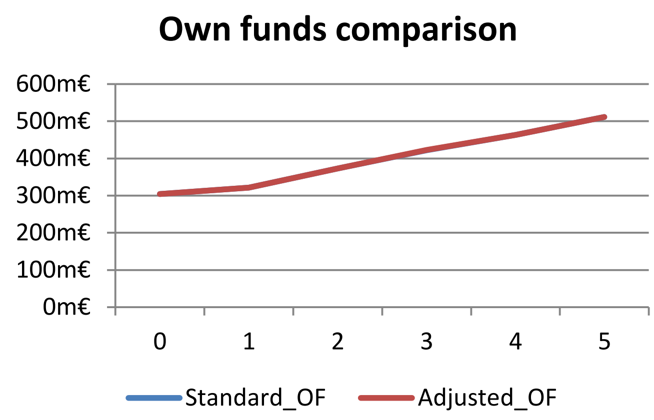
Evolution of the yield rates curves

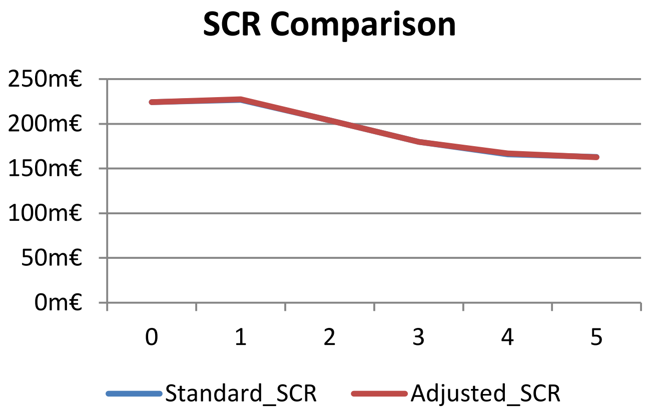


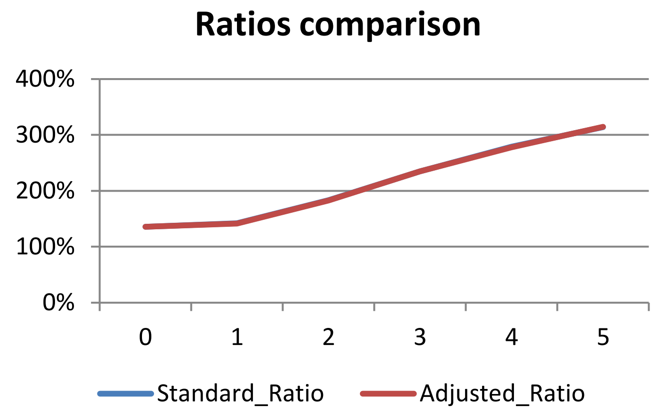
Numerical application
Results

Comparison between the adjusted method and the « standard » method









Conclusion

Pros

- Time saving : only the Pillar 1 scenarios must be generated.
- The mathematical properties of the Risk Neutral scenarios are kept : Market Consistency and martingality.
- Diminution of the Operational Risk by lowering the number of files manipulated.

Cons

- The complexity of the adjustments directly depends on the complexity of the underlying diffusion models.