Derivatives Usage in Insurance

Regulatory requirements, use cases and solutions.

by **Enrico Piccin**, Director, EMEA Business Development, Derivatives Services, S&P Global Market Intelligence

Following recent market volatility and regulatory changes, insurers must continuously develop and enhance their tools to manage derivatives with independent and reliable pricing functions and using the deepest and highest quality input data possible.

S&P Global
Market Intelligence

Contents

Introduction: Regulations and market perspective

Following recent market volatility and regulatory changes, insurers must continuously develop and enhance their tools to manage derivatives. Continuous updating is crucial to maintain an optimal balance between capital and cost on their balance sheets.

Since 2016, when Solvency II entered into force in the European Union, the requirements have become increasingly important and stricter, impacting investment, risk and capital management functions. These new standards required insurers to fully embrace solvency-related metrics in all business processes, from data sourcing (i.e., asset valuations need to reference market data that is accurate, complete and appropriate data) to outsourcing (i.e., solutions provided by vendors need to comply with the general principles for the prudential regulation of insurers to ensure independence, accuracy and expertise).

Solvency II had a far-reaching impact. Largely inspired by the European regulation, several Asia Pacific markets transitioned to new solvency frameworks, including those in Australia, mainland China and Singapore. Other markets, including those in Hong Kong, Japan, Korea, Taiwan, Malaysia, New Zealand and Thailand, are still in the process of defining or improving their solvency requirements, with expected launch dates in the coming months[1]. In the United Kingdom, the insurance market is wondering how much the PRA and HMT[2] will diverge from the Solvency II regulations adopted before Brexit.

The rapid change of insurer regulatory solvency frameworks across the world has not been the only source of disruption in recent years. High volatility in the financial markets following the COVID-19 pandemic and the recent uncertainty around the macroeconomic environment greatly impacted own funds requirements and created new opportunities in the market thanks to the volatility spillover. Particularly in 2022, capital markets experienced changes that had not been seen for decades, with sharply rising interest rates and elevated levels of inflation resulting in a mixed set of impacts on derivatives in company balance sheets and capital requirements. These events had to be jointly handled on top of the complex LIBOR transition.

During the COVID-19 outbreak, market turbulence led to sudden liquidity needs. These needs were often triggered by using derivatives for hedging, capital optimization, asset and liability management (ALM) and strategic asset allocation (SAA), a widespread practice in the insurance market. Derivatives need to be appropriately valued and stressed, so access to high quality data is key.

In the next section, we discuss challenges brought by derivatives in the specific context of Solvency II.

[1] In Asia, insurance regulations are reviewing existing risk-based capital (RBC) being effective in 2024 for Hong Kong, in 2025 for Japan, and in 2026 for Taiwan.
[2] After Brexit, HM Treasury (HMT) and the Prudential Regulation Authority (PRA) are currently adapting the Solvency II framework to the UK insurance market, tailoring the regime to the UK while maintaining robust standards for capital requirements.

Modeling Solvency capital requirements: A European example

Solvency frameworks worldwide require insurance companies to hold enough capital to cover unexpected losses driven by the risks to which companies are exposed. For instance, Solvency II requires insurers to calculate their solvency capital requirement (SCR), which is the amount of funds that insurance and reinsurance companies are required to hold under the European Union's Solvency II directive[3] to have a 99.5% confidence they could survive the most extreme expected losses over the course of a year. To measure these risks, Solvency II requires firms to use either i) a standardized approach (standard formula) set by regulators or ii) their internal model.

- **Standard formula**: A straightforward approach that requires companies to calculate capital requirements as the aggregate outcomes of several risk modules. It works by shocking market values based on predefined scalar factors. For example, in the market risks module, equities (EEA/OECD) are directly shocked by 39% of the market value, or in the case of interest rates, shocks to basic risk-free interest rates are applied for each currency at different maturities. Firms that have adopted the standard formula approach often outsource to external vendors. S&P Global Market Intelligence (SPGMI) provides raw data to firms that want to run the process internally, as well as a fully-fledged stress-test solution for institutions that want to outsource the process to an independent provider. A case study is presented in the next section of this paper.
- **Internal model**: A much wider framework offering insurance companies the opportunity to develop their own model to optimize an efficient capital/cost balance. Capital requirements are determined based on a 99.5% value-at-risk measure over one year. Two stochastic dimensions are considered: i) "outer" real-world to capture the probability distribution over one year horizon, and ii) "inner" risk neutral to evaluate assets and liabilities along each of these real-world paths.

Commonly used techniques for the internal model approach include the following:

- **Direct modelling (asset side)**: The full repricing of assets in a Monte Carlo environment (with a large number of simulations) based on the predefined distribution functions for each asset.
- **Curve fitting (asset side)**: Constructing a polynomial function that approximates the change in market values of assets as a function of the change in the underlying risk factors. It deploys a large set of market-consistent scenarios (using External Economic Scenarios Generators (ESG)[4] providers, such as Conning and Milliman) on top of the 1-year ahead real-world scenarios (refer to Figure 1).
- **Replicating portfolios (both asset and liability sides)**: Combines hypothetical portfolios trying to replicate the company's financial instruments that closely match the cash flows generated by the liabilities.
- **Least Square Monte Carlo (LSMC) (liability side)**: This new technique has raised significant interest among market participants in the last decade. It starts with a similar approach of curve fitting by deploying a large set of real-world stochastic simulations, and then applying them to the risk neutral ESG. Afterward, the multi-variate polynomial function is fitted through Least-Squares regression (refer to Figure 1).

---

[3] COMMISSION DELEGATED REGULATION (EU) 2015/35 of 10 October 2014 supplementing Directive 2009/138/EC of the European Parliament and of the Council on the taking up and pursuit of the business of Insurance and Reinsurance (Solvency II).

[4] ESG is widely used in financial services companies to simulate future states of the global economy and financial markets and price complex liabilities on a mark to market basis. Market-consistent economic scenarios are at the core of the valuation of liabilities under Solvency II, certain risk-based capital regimes in Asia, liabilities under IFRS 17, and valuation of market risk benefits under Long Duration Targeted Improvements (LDTI) for US GAAP reporting.

Proxy functions (fitting and LSMC) greatly reduce computational burden compared to a full Monte Carlo environment, i.e., nested MC of MC. LSMC provides key benefits compared to simple curve fitting: it allows more scenario points to be considered in the fitting process (i.e., more outer and less inner consequently increasing the final number of points, as shown in Figure 1 below) and the averaging out through regression results in an inherently more statistically efficient fitting process.

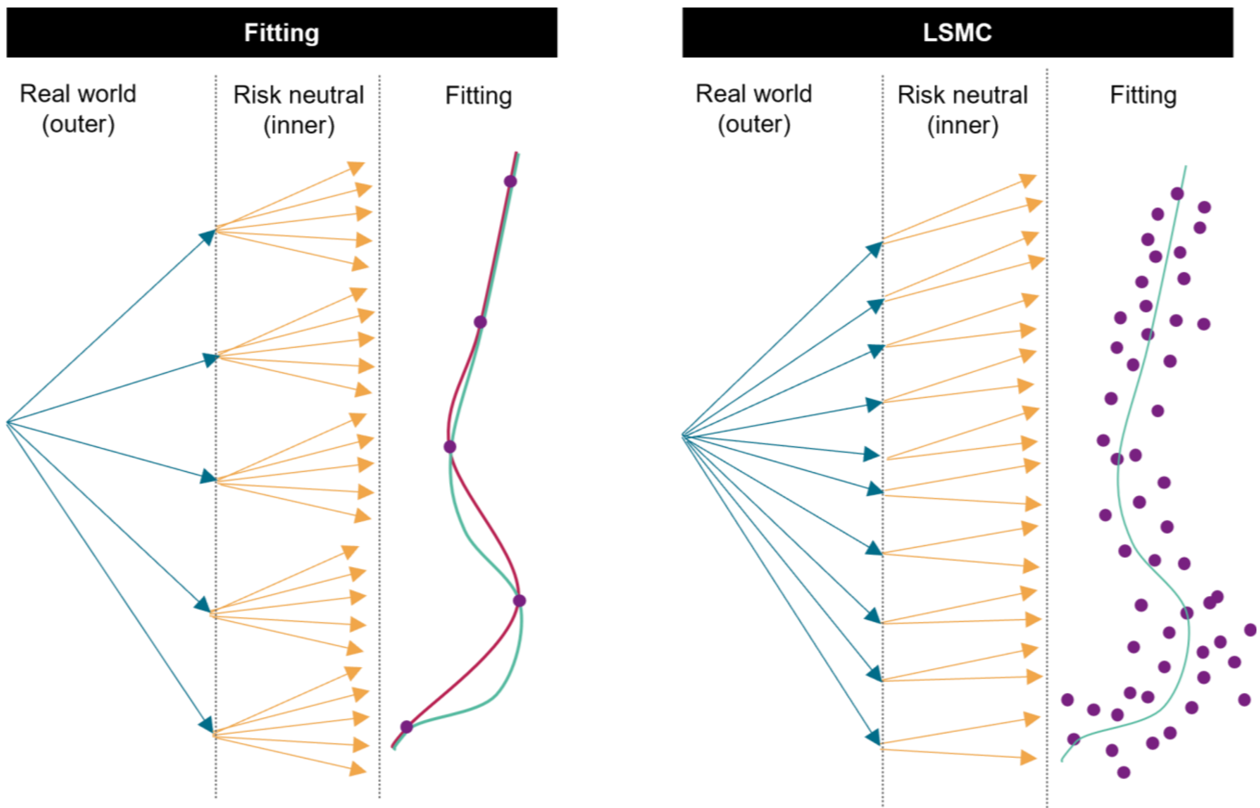

Figure 1. Graphical comparison of results based on fitting and LSMC methods

Insurers must weigh the increased complexity and extra cost of implementing the internal model approach against the standardized method considering the potential reduction in capital requirements that the former offers over the latter.

In the next section, we show the complexity in the treatment of derivatives via use cases in the context of Solvency II.

Common insurer use cases: The complexity of derivatives

In this section, we detail common problems found in insurance solvency frameworks across the globe. These frameworks fit into two closely intertwined categories: lack of qualitative data and technical challenges.

Handling calibration of parameters on the largest dataset possible

As per EIOPA guidelines, insurance and reinsurance should demonstrate that the choice of financial instruments used in the calibration process is relevant given the characteristics of their obligations. Indeed, firms should ensure that the calibration process of an ESG used for a market-consistent valuation is based on data from financial markets that is deep, liquid, and transparent. That is, data should reflect current market conditions. Furthermore, 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: calibration, Martingale and correlation tests.

Finding the most reliable and deepest data[5], in terms of volatility matrices and forward curves, is always a significant challenge in the financial markets, especially for non-liquid products. To pass the aforementioned tests, insurers need to calibrate their models on ATM options and skew across a wide strike range and long dated maturities. This guidance should be applied to the calibration of assets in the curve fitting model.

Figure 2 below represents the typical tradable universe of derivatives. While market data available on exchanges is easily accessible, it often lacks depth in the longer maturities and OTM strikes. On the other hand, OTC prices are only available via inter-dealer brokers (IDBs) or non-independent sources such as broker-dealers (i.e., banks). As a result, the information is scattered, scarce and disseminated across various market participants.

As explained previously, to achieve the best calibration possible, it is critical to source as much data as possible for positions with no reliable sources of price information, often those with very long maturities and/or far away from ATM, as represented by the large area shown below in teal blue.

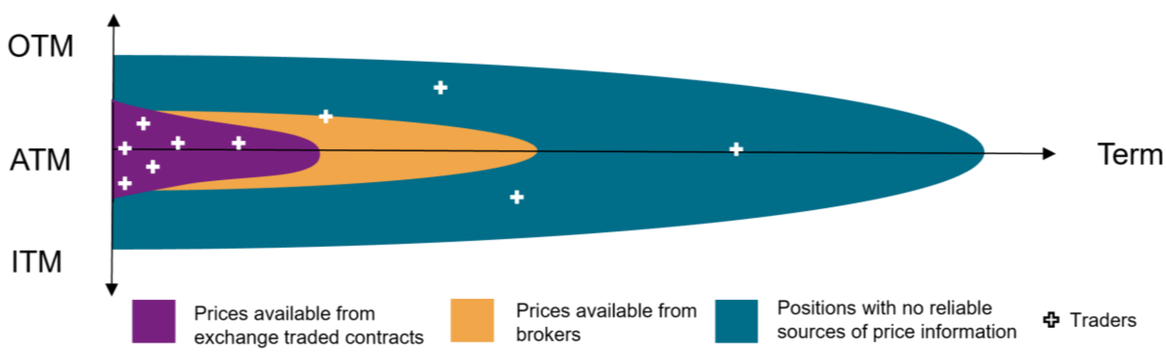

Figure 2. The problem: How and where to find information for instruments corresponding to positions for with no reliable sources of price information (shown in teal blue)

[5] Insurance and reinsurance shall have internal processes and procedures in place to ensure the appropriateness, completeness and accuracy of the data used in the calculation of their technical provisions.

Managing the risk of extrapolation error in long term maturities

Insurers often need more data for long maturities and consequently mispricing long-dated deals. The traditional answer is extrapolation, but a wide range of values may be possible depending on the technique used – since the technique impacts the capital calculated. Moreover, the main limitation in purely extrapolating data is the lack of reference to market information while relying only on the last few points of the term structure or reproducing the observed shape. This method can lead to challenging questions from regulators.

Even if long-term expectations of the market are not directly observable, banks still have exposure on the whole surface (shown in teal blue below) that they must mark for regulatory purposes. S&P Global Market Intelligence helps market-makers generate an independent mark representative of these long-term anticipations.

SPGMI blends this information with traditional data sources (such as exchanges or interdealer brokers) to produce very long dated forwards and volatility surfaces, across a wide range of underliers and strikes (illustrated in Figure 3 below)[6].

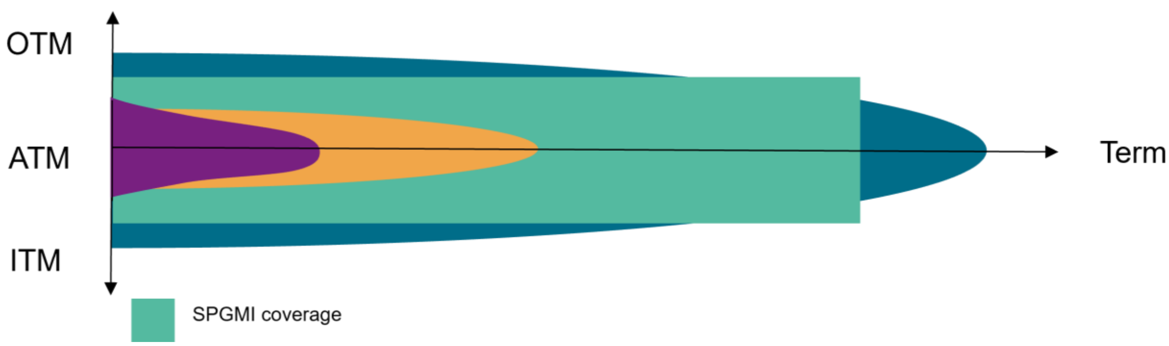

Figure 3. SPGMI coverage across moneyness and maturity term

[6] SPGMI receives quotes from market-making contributors across the entire spectrum of derivatives. These quotes are cleaned and compiled as part of a consensus generation process across Equity, Rates, FX, Credit and Commodities. For example, SPGMI can produce market data up to 25y maturities for indices, such as SPX and SX5E, for a wide range of strikes (20 to 300%).

Figure 4 below compares SPGMI OTCDD (OTC Derivatives Data) on ATM Euro Stoxx 50 volatilities (as of 29-Dec-2023) to various extrapolation techniques (constant instantaneous variance[7] and linear) after the three-year maturity. This analysis was extensively covered in a previous paper in partnership with Milliman.

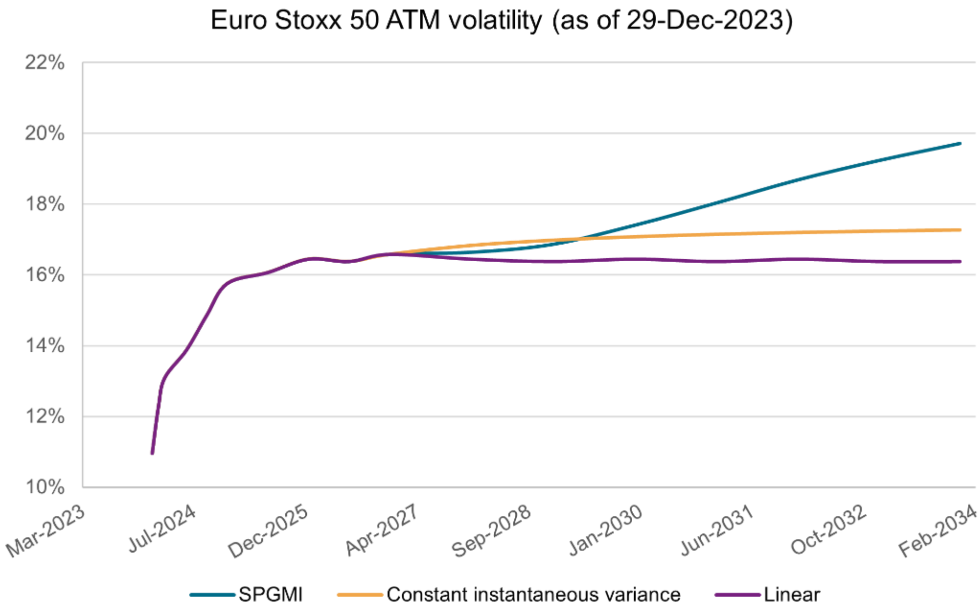

Figure 4. Comparison of various extrapolation methods

Without incorporating long term market expectations and OTC consensus data, relying only on purely extrapolating data after the final observed maturity ignores market expectations and hence may substantially misstate volatilities (in this example, it underestimates them).

Having a reliable representation of the market expectations brings many benefits to insurers. Misestimating volatilities may artificially increase or decrease the price of the options, impacting the level of capital the insurer holds. Specifically for Solvency II, reducing the use of extrapolated points can help the insurer reduce the illiquidity premium (Volatility Adjustment) in the discount rate used to value long-dated illiquid insurance liabilities, such as annuities.

[7] Refer to Appendix B for the detailed methodology.

Remediating issues with accuracy of fitting

In the curve fitting process, insurers may face two types of issues:

1. Regressing the polynomial function on non-reliable scenario points.
2. Fitting the polynomial function on derivatives with non-standard payoffs.

Polynomial regression must be run on consistent scenarios computed via accurate pricing functions. The fitting function must simulate the derivative payoff as closely as possible. For example, pricing an exotic derivative with embedded optionality, such as multiple exercises in predefined dates, does not return the same outcome if we imply the price via a binomial model versus running a Monte Carlo simulation framework. Insurers tend to simplify the computation as much as possible to optimize their capabilities. However, as the proxy function relies on the points computed by the pricing models, using degraded pricing methods may produce unreliable points under some data scenarios, thereby leading to an inaccurate polynomial regression. In this case, a bias is already introduced into the regression. The polynomial may struggle to fit a piecewise function, e.g., for non-delta one derivatives if a reliable input function (similar to the derivative payoff) is not injected. Indeed, polynomial functions are not always able to correctly fit the discontinuity of the payoff of the derivative.

Figure 5 below shows the relationship between the value of a European call option to movement in the underlying Euro Stoxx 50. Each point represents a multi risk factor scenario in which the derivative shall be repriced correctly. For equity index options, the scenarios are a combination of stressed market conditions on the spot, the implied volatility, and the interest rate. The fitted yellow line is the reliable function obtained by fitting the polynomial on the three risk factors.

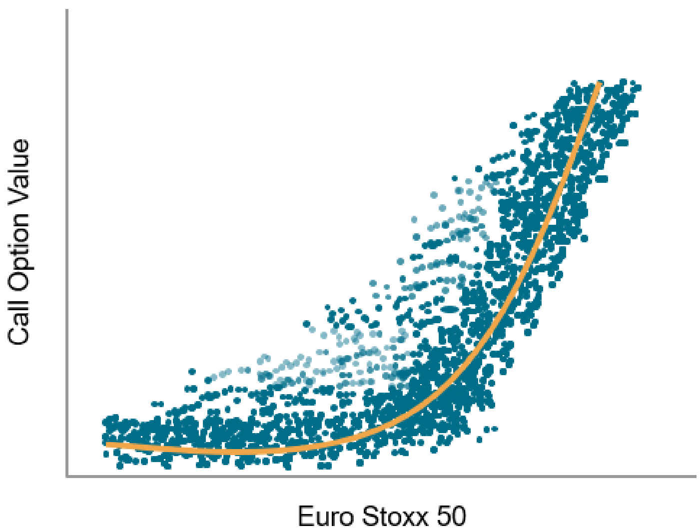

Figure 5. Relationship between the value of a European call option to the movement in the underlying Euro Stoxx 50 under multi risk factor scenarios

Missing pricing and data capabilities: Use of standard formula and stress test

Smaller insurance companies face the challenge of stress testing their deals in-house. As a result, they often focus their efforts on other activities while delegating stress testing to third parties.

Stress testing derivatives requires valuing these positions independently and accurately under specific scenarios and frameworks:

- **Regulatory purpose**: Solvency II imposes specific shocks under the standard formula depending on the risk sub-module (e.g., IR, Equity, Credit Spread, Currency, etc.).
- **Internal risk management purpose**: To handle risk appetite and limits, firms must calculate the values of their derivatives under predefined scenarios for which they are most exposed. Various stress testing methods can be used: historical, hypothetical, adverse, regulatory, etc.

Firms require flexible solutions to handle different types of methods to shock their curves. For example, not only parallel shifts, but also flattening or steepening and other shape changes are important. It is essential to have adequate and scalable solutions to handle pricing quickly.

Furthermore, historical data is essential for calibrating stress tests and add-on purposes. Companies would select the most impacted stressed period on their balance sheets between different scenarios, for example, by maximizing the impact on the SCR. It is very challenging to find historical data with long depth, high precision and granularity, especially if the portfolio is diversified into multiple asset classes and products and often in illiquid markets, such as complex derivatives or structured products.

More generally, stress testing (such as the ORSA process, which includes the stresses and scenarios selected by re/insurers and reflects their view and assessment of the risks faced) is becoming a crucial internal risk management tool. It is used by senior management to support capital decisions, provide insights into their firms' risk profiles and appetites and alert management to vulnerabilities to exceptional events. Furthermore, regulators and authorities (such as EIOPA) leverage stress tests to establish whether insurers are financially flexible enough to absorb losses that could occur in adverse scenarios.

Conclusions

Since the global financial crisis in 2007-2008, capital requirements for insurance companies have become critical. The various regulatory solvency frameworks across the globe (especially Solvency II) impose strict constraints on the insurer's own funds modeling, and the framework is evolving worldwide by intensifying regulatory expectations. The intensive use of derivatives for hedging and ALM purposes, combined with the last decade of volatile markets and mixed circumstances, has increased the complexity in handling derivatives in capital models.

Insurance companies must be able to rely on independent, reliable and efficient pricing functions for valuing their derivatives and use the deepest, most representative, and highest quality input data possible.

SPGMI derivative solutions can help insurers by providing complete and accurate datasets and by generating independent stress tests in line with the client's regulatory requirements.

Learn more >

Appendices

This section provides two appendices:

- Appendix A: Describes the SPGMI derivative solutions including our OTC Derivatives Data and Portfolio Valuations services.
- Appendix B : Describes constant instantaneous variance extrapolation.

Appendix A. SPGMI derivative solutions

S&P Global Market Intelligence offers a flexible and scalable derivatives service suite to handle regulatory requirements and investment decisions along the insurer's full life cycle, enhancing their wider asset and liability management (ALM), risk management and capital management frameworks. We leverage our high quality, accurate, transparent and independent cross-asset service with extensive coverage. S&P Global Market Intelligence solutions support insurance companies to shift from using the standard formula to an internal model, as well as helping to improve the process.

The **SPGMI OTC Derivatives Data (OTC DD) service** provides access to multi-sourced curves and implied volatilities spanning over FX, Interest rates, Equities, Credit and Commodities. It provides a unique, high quality, independent ongoing and historical cross-asset derivative dataset, starting from 2007, covering the full spectrum of skew and tenors. Our deep coverage helps insurers to improve the calibration of reliable scenarios (real world, risk neutral and ESG) and fit pricing parameters to a bigger coverage of non-observable prices. Uses cases are i) in curve fitting model, insurers can calibrate their equity implied volatility risk factors on ATM options and skew across a wide strike range and long dated maturities, ii) in LSMC, fitting model parameters for ESG simulations (e.g., SABR) on the whole skew of swaptions, and iii) for historical stressed scenarios for capital add-on purpose. SPGMI OTCDD volatility surfaces are calibrated from a blend of exchange information and market-maker consensus information for best quality, transparency and the deepest coverage possible.

For more information, see our web site:
OTC Derivatives Data | S&P Global

The **SPGMI Portfolio Valuations (PV) service** helps insurers in their full valuation of derivatives, structured products and illiquid securities. Our service computes valuations i) using shocks defined by the Solvency II standard formula, ii) as input of scenario points of the fitting function (curve fitting model, LSMC), and iii) for stress testing purposes, with the flexibility to set up ad hoc scenarios at the client's convenience. It provides independent valuations for a wide range of vanilla and exotic derivatives across multiple asset classes, under a range of stressed scenarios, as well as positions in a range of cash securities covering FX, Interest rates, Equities, Credit, and Commodities.

For more information, see our web site:
Portfolio Valuations | S&P Global

Our derivative solutions, including **SPGMI OTCDD and PV services**, can further help clients in the price discovery process, with the aim of anticipating trends and exploiting market opportunities in the context of derivatives hedging, capital optimization, asset and liability management, and strategic asset allocation. Insurers can leverage high quality and accurate levels of IR yields as insights to anticipate market movements in the duration matching process. Furthermore, widely skewed volatilities help CIOs in their investment decisions for derivatives and for capital optimization.

Appendix B. Constant instantaneous variance extrapolation

Volatility beyond last observed point can be calculated by flat extrapolating the instantaneous variance for each strike K. We define T_N and T_{N-1} as the time to maturity of the last two known expiries and σ_{N-1} and σ_N the corresponding implied volatility, where the instantaneous variance σ_{N-1} can be calculated as follows:

$$var_i(K) = \frac{var_N(K) - var_{N-1}(K)}{T_N - T_{N-1}}$$

where

$$var_N(K) = T_N \sigma_N^2(K)$$

$$var_{N-1}(K) = T_{N-1} \sigma_{N-1}^2(K)$$

The extrapolated volatility for maturities beyond the last observed points can then be calculated by assuming that the instantaneous volatility remains constant.

$$var(K) = (T - T_N) * var_i(K) + var_N(K)$$

$$\sigma(K) = \frac{\sqrt{var(K)}}{T}$$

Contact us

Asia-Pacific

mk-ddvsapacbizdev@spglobal.com

Europe, Middle East & Africa

mk-ddvsemeabizdev@spglobal.com

The Americas

mk-ddvsnabizdev@spglobal.com